THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 445.

CABLE REVENUES.

HAVE submarine telegraph cables, as dividend-earning concerns, seen their best days? It is devoutly to be hoped not; but present appearances are not very cheering from a shareholder's point of view. With scarcely an exception, diminished receipts have been the most conspicuous feature in recent directors' reports, and while in some instances the deficiency may to an extent be accounted for by local and special causes, depressed revenues are far too general to be separately dealt with and attributed to incidental and various circumstances. We have long held the opinion, and have not scrupled to express it, that the administration of many of the leading cable companies is not conducted on the wisest or most economical principle, and we feel pretty sure that one very considerable branch of the cable system will suffer to no small degree in the months that are to come, mainly as a consequence of its wrong-headedness in the past. An increasingly large proportion of the receipts which formerly went through the coffers of this section now find another medium of circulation, and, notwithstanding the determined, even desperate, attempt recently made to regain the monopoly which has been lost, are likely to continue flowing in that other channel. But the contest in the Atlantic does not answer the whole question. On lines where there is, practically speaking, no competition, such enormous quarterly decreases are recorded as ten, twenty, and up to forty thousand pounds. It can scarcely be the fact that merchants and others are tiring of the telegraph, which has been of such enormous service to them during the past decade or so. What probably more nearly accounts for the change is, that the users of the submarine system, wise in their day and generation, have devised such means for conveying the maximum amount of intelligence in the minimum number of words that, transacting an equally large, or even a greater, volume of business over the telegraph wires, they pay a much smaller sum of money for the convenience. The Chairman of the Submarine Telegraph Company has found it for some years an interesting study to trace the gradual decrease in the number of words per message sent over his lines, and while, as he has often said, this system of contraction and condensation must come to an end somewhere, the limit has apparently not yet been reached, and the only hope which shareholders of the various companies can have is, that their directors will display an amount of wisdom and business tact in coping with the difficulty for which they have decidedly not been famous hitherto.

PRIMARY BATTERIES.

A DISCUSSION has been commenced in our pages on the Schanschieff primary battery, and we hope shortly to have something definite to say on our own account respecting the inventor's claims. At the moment, however, we do not intend to make known the impression we have formed thereon, but to call attention to a matter which we fear has been too often overlooked by the sanguine inventors of primary batteries. A short time since a transatlantic contemporary published a paper by Mr. Fitch on "The Relative Working Values of Battery Materials."

To this, a correspondent, Mr. Allan V. Garratt, replied in the following terms:—"Very few men now-a-days question the relative electrical efficiency of two chemicals pound for pound, but *dollar* for *dollar*. According to Mr. Fitch's tables, it is demonstrated that a pound of chloride of silver can do 1·738 (or about $1\frac{3}{4}$) times the work of a pound of blue vitriol. Very true; but from the same data I can demonstrate that a dollar's worth of blue vitriol can do the work of one hundred and twenty-five dollars worth ($125) of chloride of silver . . . It is no exaggeration to state that in several forms of batteries very widely used at present, the labour of attending to them costs as much as, if not more than the chemicals actually consumed in the battery . . . Here comes in one of the great advantages of the use of bichromate of soda over bichromate of potash, for not only has it a higher electrical efficiency, pound for pound, and not only can you buy more of it for a dollar, but you can make several pounds of it occupy (in a battery solution) the space of one pound of bichromate of potash; and when the battery is exhausted the labour required to clean it up is much less than with bichromate of potash."

It appears to us that Mr. Garratt's remarks are borne out in the paper by Mr. Peukert which we published last week. This gentleman showed that 500 watts could be produced hourly for, say, one shilling, with the Daniell battery; but that the same amount of electrical energy from Bunsen elements would cost one shilling and sixpence per hour.

Ten of the Woodhouse-Rawson 20 candle-power lamps could be kept at their normal luminosity by the expenditure of 500 watts, so that the expense of a 20 candle-power lamp would be, if run from Daniell's cells, about 1·2 pence per hour. We know that the electromotive force of the Daniell battery is low, and that its resistance, in the form usually employed, is high; but it is very constant and cheap to manufacture. Would it not be worth while making an attempt to devise a form of this battery which could be used for electric lighting. The majority of, if not all, the primary batteries hitherto brought out supply us with electrical energy at too great a cost; for an expenditure of say three pence (the average cost per hour of most primary batteries) for a 10 candle lamp is little short of indulging in a luxury.

HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

VII.—COMPOUND MACHINES *(continued)*.

HAVING found this position and marked it, the test for determining the ampère windings may be made as above described, the results being the required exciting current for each different number of lamps to bring the machine to its desired potential. This current multiplied by the number of windings of the temporary coils gives the number of ampère windings required for supplying a constant potential to a varying number of lamps.

Having made all these adjustments and the series of measurements for determining the ampère turns for different numbers of lamps, it is advisable, though not absolutely necessary, to make the other test for determining the magnetic curve, as was described for shunt machines. It is more necessary to do this in the case of compound machines than for either shunt or series, as it enables one to see up to what limit the machine may be made to have a constant potential, and also to see whether it is practicable to attempt to make it compound at all. If there is any doubt about its being well-proportioned for a compound machine, it is best to make this test first, in order to save the trouble of the other test in case the proportions are found to be too bad for a compound machine. How to improve the proportions from the results of this test will be discussed later.

From the results of this test for the relation between the useful magnetism and the ampère windings, lay off the values of the potential on open circuit and the magnetising ampère windings as abscissæ and ordinates, respectively, and draw the curve through the points in the same way as described for shunt machines. If the machine is properly proportioned, this curve should be two tolerably straight lines connected by a short, curved line, as, *a*, *b*, in fig. 5. As the ampère windings must, from the nature of the compound winding, increase in direct proportion to the current of the machine, it is evident that the machine may be made compound only on one or the other side of the curved part, *c*, *d*, of the line, *a*, *b*; that is, for the curve represented here, the extreme number of ampère windings must be equal to or less than that for the point, *c*—that is, equal or less than *h*, *i*; or the smallest limit must be equal to or greater than that for the point, *d*—that is, *d*, *e*. It cannot possibly be made to have a constant potential for a number of ampère windings lying between *c* and *d*, except, perhaps, approximately for a very short range, if the curve is not a sharp one. As the point, *c*, designates the point at which the magnet cores are just being saturated, it will evidently be more economical to run the machine between the points, *a* and *c*, rather than between *d* and *b*, for it will then require less energy in the magnets, and, therefore, also less wire, as the amount of thick wire (series coils) will be very much less for points below *c* than for points above *d*, as is evident. If the curve is not even approximately straight at one of the two parts, it is not advisable to attempt to make the machine self-regulating with a constant potential without adjusting the brushes, except for very small ranges of the varying load. In general, the straighter this curve below the saturation point, *c*, the more nearly can the machine be made to have a constant potential.

Having made this examination and found the maximum limit to the number of ampère turns, take the results of the tests first described, for determining the ampère windings required for supplying the same potential to different numbers of lamps, and construct a curve from the values obtained, by laying off the current in the armature as abscissæ, and the required number of ampère windings as ordinates, plotting the points and drawing a line through them. This line will be somewhat like the curved line, *g*, *f*, in fig. 5, and may for the sake of direct comparison be drawn on the same sheet with the other curve, by taking the abscissæ as ampères instead of volts. The line, *c*, *k*, representing the permissible limiting value for the ampère windings, shows, by its intersection, *h*, with the curve, *g*, *f*, the extreme number of ampères, *h*, *k*, or *i*, *o*, for which the machine may be made self-regulating. The line, *g*, *n*, shows the smallest number of ampère turns which will ever be required (on open circuit), and, therefore, by its intersection with *a*, *c*, at *n* shows the limiting portion, *n*, *c*, of the curve, *a*, *c*, which is in actual use. If this part of the curve, *a*, *c* (which, under good conditions, will be very small), be straight, or nearly so, the machine may be made self-regulating, even if the rest of the curve, *a*, *b*, is very much curved. This portion, *n*, *c*, may be made quite small by making the armature resistance very small and making the number of turns on it small, as will be seen later.

It may be remarked here, that if the test had been continued for a greater number of lamps than that which is represented by the distance, *o*, *i*, the curve, *g*, *h*, would have been found to curve upward like *h*, *f*, due to the fact that the magnets are being saturated. The machine can be made self-regulating only for the tolerably straight portion of the curve, *g*, *f*. Furthermore, if *n*, *c*, is curved considerably, *g*, *h*, will also be so in about the same proportion and in the same direction.

To calculate the number of ampère windings which must be allotted to the shunt and to the series coils, draw a straight line, *g*, *h*, through the curved line, *g*, *h*, making it coincide more nearly with those portions of the curve which represent the numbers of lamps which will be used most frequently with that machine. For instance, at *g* the curve will probably deviate most from the straight line, but it is not necessary to consider that part of the curve, as the machine will probably seldom be used for such a small number of lamps.

The vertical distances to this straight line, *g*, *h*, represent the ampère windings which can be supplied by a winding consisting of series and shunt coils, and is, therefore, the nearest approach possible with such a winding to generate the ampère windings required by the curved line, *g*, *h*, obtained from the test. The more this straight line deviates from the curved one, the greater will be the deviation of the potential from the desired constant value.

From the position of this line the proportion of the series and shunt coils is calculated as follows: as to the vertical distance representing ampère turns, it is evident that these distances are made up of a constant part, *g*, *o*, and a regularly increasing part lying between the lines, *g*, *p* and *g*, *h*. It is evident, therefore, that the shunt coils, in which, as was described, the current is approximately constant for any number of lamps, must supply the ampère windings represented by *g*, *o*, and the series coils must supply the constantly increasing portion.

Up to this point it is immaterial which of the two methods of winding is to be used. In many cases it will make so little difference whether the long shunt or the ordinary method is used, that the same calculation will answer for both. Furthermore, if it is not necessary to make the machine regulate automatically as accurately as it is possible to make it, then certain corrections may be neglected, in which case also the same calculation will answer for both methods.

The conditions under which the following calculation can be used for both cases is as follows: if the machine is large; if the relative armature resistance is small; if the proportion of energy required in the magnets is not too large; if the shunt current may be comparatively small; if the brushes may be shifted slightly to adjust; if an adjustable resistance in the shunt circuit may be used within small limits; if the magnets are not over saturated; if the speed is not quite constant, thus necessitating hand regulation.

Under these conditions the following approximate method may be used: the shunt coils are calculated the same way as for an ordinary shunt machine from

the number of ampère windings represented by the distance, g, o, the only difference being that the current is a smaller proportion of the whole current than in ordinary shunt machines, as will be seen. The series coils are calculated as follows: for a current in the armature, represented by o, i, the ampère windings must be increased by an amount represented by h, p ampère windings, in addition to that supplied by the shunt magnets. As this same current, o, i, flows through these series coils as well as in the external circuit, it is evident that the number of windings of the series coils must be this number of ampère windings represented by h, p, divided by the current

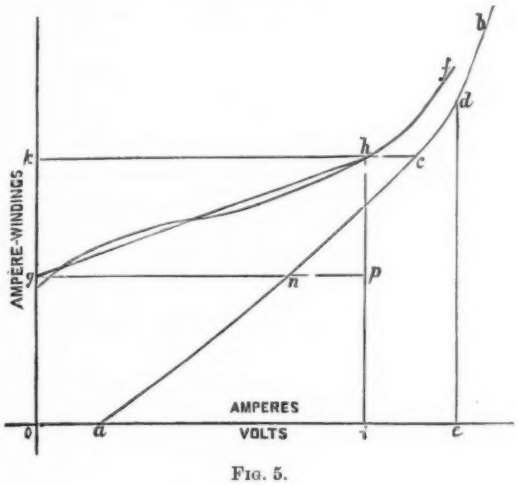


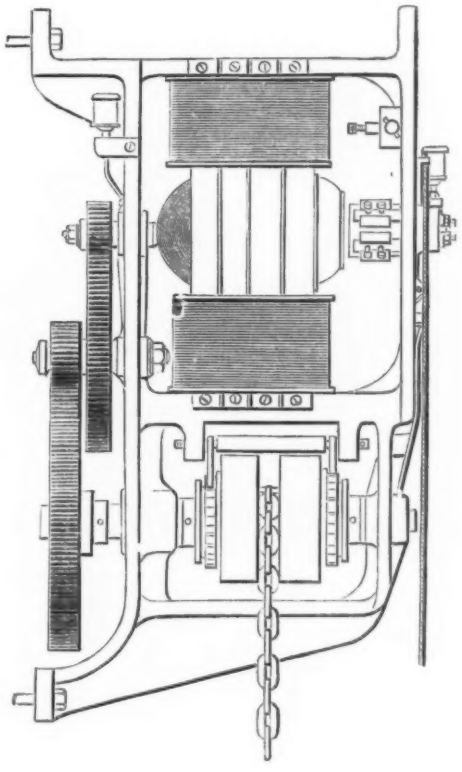
FIG. 5.

represented by o, i. The number of windings thus obtained will evidently be the same, no matter what the current supplied be, as it depends only on the angle, h, g, p. The diameter of the wire must be calculated the same way as for a series machine, from the maximum current, o, i, and the allowable fall of potential, which in this case must be much smaller than in a series machine. In general, the whole allowable loss of energy for the magnets can be divided into two parts, which have the proportion which the distances, h, p, and p, i, have to each other, and to the whole distance, h, i, giving the series coils that part, h, p, of the whole, h, i, and the shunt the rest. For instance, if h, p is one-third of h, i, then the series coils may absorb about one-third of the whole amount of energy allowed for the magnets, and the shunt coils the remaining two-thirds. If 3 per cent. of the whole energy is allowed for the magnetisation, then in this case the series coils may absorb 1 per cent. of the potential, and the shunt coils 2 per cent. of the maximum current.

As will be noticed, this method does not take into account the fact that the loss of potential in the series windings should be replaced by an increasing potential at the armature; neither does it take into account that the shunt coil current should be subtracted from that in the external circuit and series coils. Therefore, the potential of the finished machine, although approximately constant, will not be as much so as it would be possible to make it if we were to correct the proportions of the windings for the above mentioned losses. These corrections become all the more necessary, in fact sometimes quite essential, under the following conditions: if the machine is small they are essential; if the armature resistance is relatively high, that is, if the series coils supply a great part of the ampère windings, the correction for loss of potential is important, and if the magnets are over saturated this correction generally becomes essential; if the required magnetisation is relatively great, and the shunt current relatively large, the correction for this shunt current is important—in general, if the proportion of energy required by the magnets is large, both corrections become necessary; if constant speed can be maintained, and it is required to make the machine have as nearly a constant potential as it is possible to make it, then both corrections should be made.

AN ELECTRICAL HOIST.

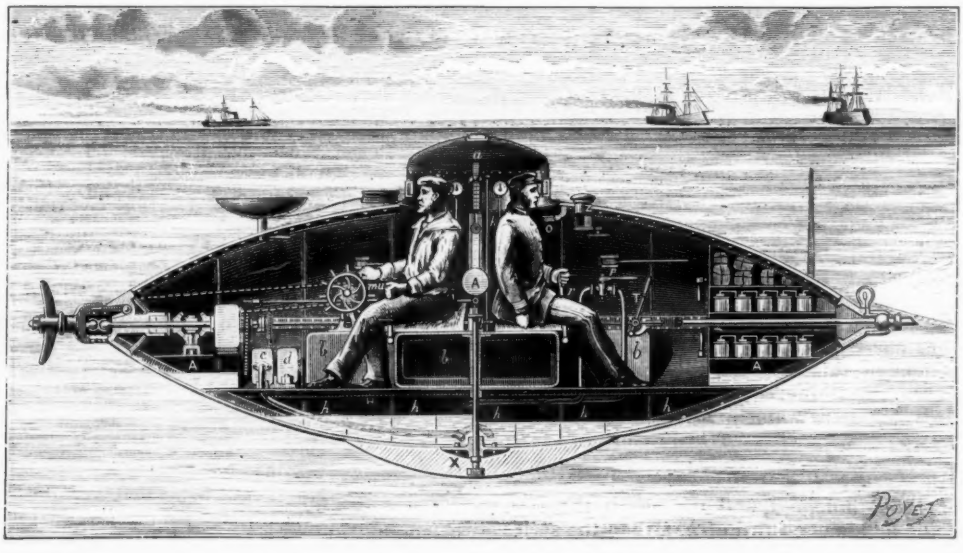
AMONGST the advantages possessed by a dynamo-electric machine, that of its being able to be utilised for the transmission of power, says the *Mechanical Engineer*, must be considered as one of the greatest; and, as the result of manifold experiments and subsequent practical working, it has been shown that the dynamo is the most perfect and economical machine for the conversion of one form of energy into another. Amongst the various ways in which the electrical transmission of power has been applied, a very important and interesting form is that of the "electrical hoist" designed by Dr. John Hopkinson, F.R.S., and manufactured by Messrs. Siemens Bros., which we illustrate, and which partly explains itself. The electrical portion consists of an ordinary Siemens series-wound dynamo (D_2), fitted with gear for reversing the direction of the current and the lead of the brushes, and, consequently, the direction of rotation of the



machine. In the mean position, when the dynamo is at rest, both pairs of brushes are lifted from the commutator, allowing no current to pass. The dynamo runs at a high velocity, and is connected by spur gear to the lifting axle to diminish the speed of lift. On this axle a chain pulley is fitted by means of a special friction clutch, which automatically holds the weight attached to the chain, as soon as the dynamo is stopped. From the terminals on the right of the machine suitable conductors are carried to the generator. The rope on the same side is in connection with the starting and reversing gear, and when the generator dynamo is running the hoist can be used as required, and however remote from the generator.

In large mills or works where the application of power is frequently required in various places, and where it is not only costly but simply impossible to transmit power by shafting, it would become necessary to provide power from separate and distinct steam or other motors ; these would in the ordinary way necessitate special attendance, and extra cost would therefore be entailed in the maintenance. In the case, however, of the electrical transmission it would be only necessary to carry conducting wires to those points where power was wanted, and fix the motor attached to gearing of the form required, in one place a hoist, in another a motor to drive a saw, a pump, or any purpose desired. In works or buildings where such a dynamo acting as generator should be fixed, it could be used at dark for lighting the place with incandescent lamps, and, again, where a dynamo has been fitted for the purpose of an electric light installation, it can be used during the daytime for the transmission of power wherever required.

The electrical hoist has been found of such great advantage and utility that it has been fixed in a good many places, and it has been proved to be capable of lifting varying loads with the greatest ease and certainty, and, the action being simple and easily understood, does not necessitate constant attention or the employment of skilled hands.



GOUBET'S SUBMARINE BOAT.

THE motive power for propelling this vessel is supplied from secondary batteries, and the electro-motor is calculated to give her a speed of 5 knots an hour. The cells number 30, 6 of which are used as a reserve. The motor is a Siemens dynamo of the type applied to tramways ; it weighs from 180 to 200 kilogrammes, and works with an E.M.F. of 48 volts and a current of 8·8 ampères. Under these conditions the boat is provided for for 10 to 12 hours. In the case of submarine explorations it might be worked during submersion by the generator of the vessel to which it would be attached, by means of the electrical transmission of power.

The torpedo is placed in the rear of the hull. The transmitting wire is coiled on a drum outside, and is connected with the commutator placed under the hand of the officer.

In the fore-part, a cutter, which is enabled by means of the lever T to project from the boat for a length of 3 metres, serves to cut the wires of the torpedoes of defence ; it is lighted by an incandescence lamp.

On arriving underneath the vessel to be attacked, which can be seen through the headlight, the officer works a pump in order to get vertically underneath, and then releases the torpedo, which ascends and attaches itself to the hull of the vessel by means of grapplers. The boat then recedes, the wire coiled round the drum unrolls and at the same time indicates the distance traversed. When this is sufficient, the officer effects the explosion. Then the boat ascends to the surface by emptying the reservoirs and regains the vessel to which it belongs.

The boat can be kept in communication with the principal vessel, either by means of a telephonic wire if it remains near, or by means of rockets.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

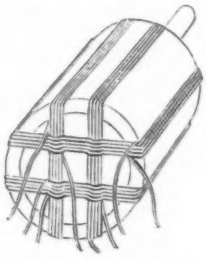
[*All rights reserved.*]

(*Continued from page* 505.)

THE original armatures of the Von Hefner Alteneck machine, more widely known as the Siemens dynamo, were, curiously enough, constructed much after the fashion of that which Professor Rowland devised and which he, in my opinion, so unaccountably kept to himself. I mean that the wires which cut through the magnetic field were not coiled tightly upon the iron ring as in the Gramme form, but were free to slide over the surface of the ring which itself remained stationary. This arrangement is now however a thing of the past, and I do not think it necessary to enter upon a more minute description thereof, so we will away to the Siemens machine proper. Its chief peculiarity lies in the manner of coiling the armature. This is generally made considerably longer than is the Gramme, and may be said to be a hollow cylinder rather than a ring as generally understood. The copper wires as you have already seen are in the Gramme ring, threaded in and out so that both outer and inner surface of the ring is covered with wire. In the Siemens armature on the contrary the outside surface only of the cylinder bears the wire. It is in fact carried lengthways along one side of the cylinder, then across the end, along the other side, across the other end, and so the operation continues until sufficient wire has been wound to form the necessary thickness of coil. This sketch will give you a very good idea of how the operation is performed, and although for the sake of clearness I show a few coils only you will understand that the cylinder is completely covered in like manner, the number of coils

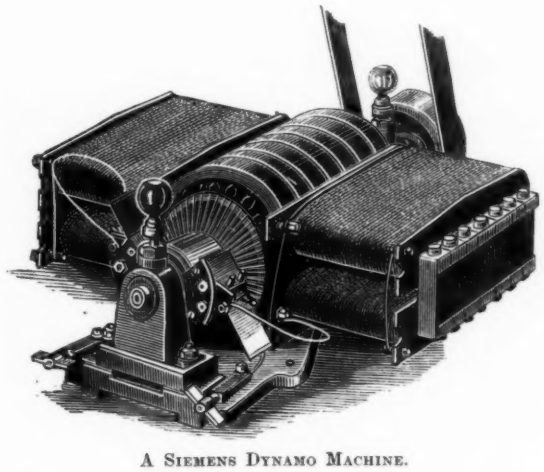
depending upon circumstances, such as the duties which the machine is called upon to perform, &c.

The free ends of the coils are fastened to the metallic slabs of the collector in the manner of Gramme. The field magnets differ somewhat from those usually found in other dynamos, but this is a matter of detail which does not affect the general reader. From the time of which I am now speaking to the present day, the Gramme and Siemens machines have run a neck



METHOD OF WINDING COILS ON SIEMENS ARMATURE.

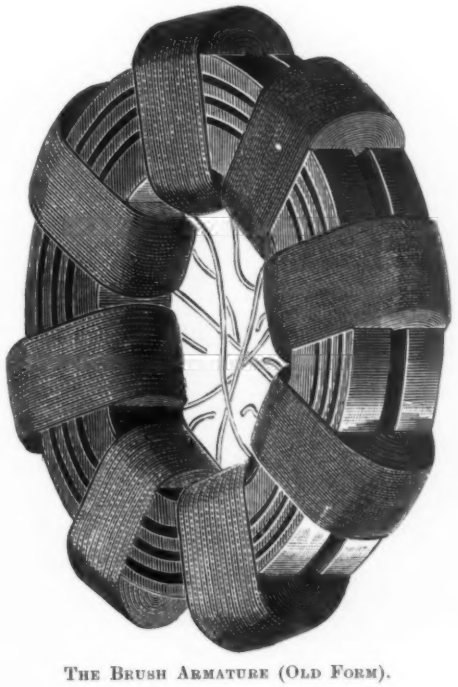
and neck race in public estimation, and although as you know fashions may differ and the guise in which one appears to-day may be very materially altered a short time hence, yet the majority of the machines by which you are here surrounded, and which to the untrained eye present such differing features are, with a few honourable exceptions, built strictly upon the lines traced out by Gramme and Siemens. I look upon these two machines as the pioneers of dynamo machine construction; they have been the means of showing the way to the further development of the dynamo in other hands as the most economical converter of one form of energy into another, and they still hold their own as typical examples of my evolution. The various steps which led to their formation having been explained it becomes a matter of comparative ease to



A SIEMENS DYNAMO MACHINE.

understand the thousand and one modifications which more modern inventors have brought forward with more or less success. I do not intend then to enter so fully into the construction of these latter-day machines, but there are several yet to be dealt with which deserve more than a passing notice. Having seen what has been accomplished by the able men of England, France, and Germany, I will now take you for a while into the real home of the dynamo. It is in America that I and my fellows are most highly appreciated, and the members of my family which there spring into existence are so numerous that our numbers may soon be fairly compared with those of the prolific rabbits which have so overrun your Australian colonies. Foremost amongst your trans-Atlantic cousins, a Nestor amongst dynamo constructors, stands Mr. F. C. Brush. It is proverbial that "a new brush sweeps clean," and when Mr. Brush appeared upon the scene there was no exception to this rule. His name is almost a household word, or at all events it should become so through you, and his dynamos have swept not only his own country, but ours also, from end to end. The most characteristic feature in the Brush dynamo lies in the form and construction of the ring, together with the method of coiling and connecting up. Comparing it with that of Gramme, I need only remind you that in his ring the coils are wound contiguously to one another completely covering the iron, and that their ends are connected to one another in consecutive series, so that the currents generated in the armature circulates in all the coils.

The Brush ring is based somewhat on that of Pacinotti, only the teeth or projections are formed on each side instead of around the periphery. The diametrically opposite coils are alone permanently connected together, and the current generated when the armature is in motion does not therefore traverse *all* the others, as will be afterwards pointed out. As in the Pacinotti ring the coils are separated by the iron projections, which are here, however, of larger sectional area.



THE BRUSH ARMATURE (OLD FORM).

The pole pieces of the field magnets are in this machine placed on *each side* of the ring, and not above and below as in the Gramme and Siemens dynamos; the Brush generator has, therefore, nothing in common with these, either in the disposition of field magnets or the position of the revolving wires cutting through the magnetic field.

The Brush ring as formerly made was of cast iron, with channelled recesses on each side, in which the copper wire coils were wound.

This sketch is a faithful representation of the armatures which were constructed till within a very short time ago, but an improvement has been made which consists in forming the ring with thin iron ribbon. In the old form there were currents set up in the *iron*, which are generally termed Foucault or "eddy" currents, and these had a deleterious effect upon the working of the machine, as indeed they also have upon any dynamo. With the new form of armature these detrimental reactions have been almost

eliminated, and the most recent machines are now enabled to generate, with the same size of armature and running at the same speed, much more electrical energy than was formerly the case. As an instance I may tell you that where with an old machine 40 arc lamps were supplied with current, 65 lamps can now be kept alight by a new armature at the same speed.

(*To be continued.*)

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 501.)

Wednesday, May 12th, 1886—(*continued*).

DR. FLEMING, cross-examined by the SOLICITOR-GENERAL: Supposing a person made a carbon burner without either carbonising a fibrous vegetable substance or making a carbon wire of lampblack and tar, he would not be using such a carbon filament as Edison describes, would he?—I do not gather from the specification that it exclusively refers to those two materials alone.

He claims a carbon filament, according to your view, of any kind?—Yes.

A filament means a thread, does it not?—I think it means something more than a thread. I understand by the word filament an elongated body of small cross-section which possesses some qualities of elasticity as well as flexibility.

Can you point out to me a single passage or word in Edison's patent in which he speaks of either elasticity or flexibility?—I think they are implied in what he describes.

From what words?—From the use of the word filament.

The primary distinction between a filament and a pencil would be the comparative sectional area?—I think so.

MR. JUSTICE BUTT: I think you say, "I think the word filament involves flexibility and elasticity?"—Yes.

The SOLICITOR-GENERAL: I suppose you would agree that a thread may be made of all degress of elasticity?—Certainly.

You may have a non-elastic thread, may you not?—I do not recollect ever having seen one.

What do you say of netting?—I think that is elastic to some extent.

Supposing one of the fibrous vegetable materials would be a bit of wood, a fragment of wood. That would be a fibrous vegetable material?—If it complied with these conditions.

"A fibrous vegetable material carbonised in a closed chamber;" that might be a bit of wood, might it not?—Certainly.

That would vary very much in rigidity from other fibrous materials you could suggest, would it not?—Certainly.

So that there are all degrees of rigidity and elasticity which would come under your description of a filament?—Yes.

From perfect elasticity and flexibility, or what we unscientific persons may call almost perfect, up to complete rigidity and non-elasticity?—It is impossible, I think, to draw a hard and sharp line in these matters.

Would you describe a wood splint as an elastic flexible material?—If it had sufficiently small cross-sections.

It is not a material you would select for elasticity or flexibility?—It is not, perhaps, the best example of an elastic and flexible body.

You would not select elasticity and flexibility as two qualities of a wood splint?—I should say it possessed those qualities.

But in a less degree than other materials which might be named?—In a less degree than some and more than others.

Have you looked at Pulvermacher's patent of November 23rd, 1878? I am quite aware that it relates to arc lighting. "My improvements relate to various apparatus for the production of electric light varying according to the methods employed, either lighting by the voltaic arc or by incandescence." That would apply to an incandescent lamp as well as to a voltaic arc, would it not?—Yes.

"For lighting by the voltaic arc, the principal organ or medium I employ is composed of two parts, invariably connected together, which I term 'rod spiral.' The central portion of this rod consists of a thinner rod composed of a paste or compound of finely powdered pure charcoal mixed with tar and pitch, or by compression of lampblack, and obtained by pressure through a draw plate." Would not that produce a wire very much like Edison's tar and lamp-black wire?—It would be a similar composition.

It would be practically identical? It is a mixture of lampblack and tar, is it not?—It would be nearly the same.

The baking operation to which Pulvermacher further on refers would be carbonisation, would it not?—Yes, I think so.

Do you not find there a wire composed of lampblack and tar kneaded together into a putty described as a material suitable for carbonisation?—I find a description of such a material, and that it could be carbonised.

And intended to be wound into a spiral, is it not, before carbonisation?—It is wound before carbonisation.

Does not Edison also propose to coat his tar and lampblack wire with a non-conducting non-carbonisable substance?—Yes, he does.

Supposing he did that, would he not obtain a material which would be identical with Pulvermacher's rod spiral?—It appears to me it would be nearly identical.

In another part of his patent, page 5, line 15, he says:—"The surrounding or enveloping part consists of a thinner carbon rod or thread also obtained by pressure through a draw plate. This thin rod is provided in the course of manufacture with a simple textile thread forming a kind of core and giving strength to the carbon." Would not that be precisely similar to what Edison has described on page 4, line 9:—"I sometimes roll a thread within a compound of lampblack and tar, so as to allow of greater convenience in handling the same?—Yes, I think it is.

Is it not used for the same purpose, that is, to give strength to the carbon? Is not that what Edison means when he says, "So as to allow of greater convenience in handling the same?"—Yes, I think it is.

With regard to your experiments on Swan's lamp. I think you told us the carbon conductor was $\frac{1}{25}$th of an inch in sectional area, and you described that as a rod or pencil. Where do you draw the line between a rod or pencil and a filament?—I do not think it is possible to give absolute dimensions.

Edison has not attempted to give dimensions except in regard to the lampblack and tar?—Except with regard to the lampblack and tar.

Can you tell us what the resistance of the lamp which you called high was?—In one measurement that I got it seemed to me to approach 500 ohms.

Where there is greatest resistance there would be greater heat, would there not?—There would.

And heat which would fuse the metal attachments?—If their temperature were high they would undoubtedly fuse.

I will ask you a question about Gimingham's patent. As I understand the description of his invention, it consisted of placing the carbon burner in sockets of platinum?—Carbon filaments in sockets of platinum.

They fashioned the ends of the platinum wire into the form of a socket, and his idea was that the carbon would rest in those sockets?—It was his idea.

He did not state any means for squeezing the carbon. Have you ever tried Gimingham's pure and simple to find whether that answers?—I have.

Do you not find that it gets loose?—Not in the lamps I have had made in that manner.

Without the application of any cement or pincers or anything of that kind?—Without any application of cement or anything of that kind.

Did you not find that owing to the heat of the carbon when the current passed through it it enlarges the platinum socket and the conductor becomes loose and uncertain?—Not if the socket were well made.

There is no novelty in the way in which he describes the making of the socket? It is as well known as possible that you can make a socket by flattening the end of a thing and then drawing it through a draw plate?—The mode of manufacture is no novelty.

The novelty you suggest is in the application of it to uniting carbon and platinum?—Yes.

Can you tell from the appearance of the lamp handed to you whether the platinum had been pressed by nippers or other mechanical means on to the carbon?—No, I could not gather from the appearance.

You do not know whether, without the application of such mechanical force to Gimingham's socket, it would work, the conductor would be too uneven, too variable?—I think the platinum would have to be pressed round the carbon to make a joint.

You do not find in Gimingham's patent that he has told the world that in order to make the conductor as he proposes it would be necessary to press the platinum round the carbon? His idea was simply to put it into the socket and leave it there?—He says: "I mount the carbon filaments directly in these tubes."

He does not say anything about pressing the carbon into the socket?—I think that is implied in the word "mount;" I think he depends on the grip of the carbon and the tube.

Without the application of any such mechanical means as I have suggested, of a pair of nippers, or anything that you would use for the purpose?—I think those must be used in putting it in.

Did not Swan use platinum sockets?—Some kind of sockets.

MR. MOULTON: I think I ought to refer my friend to this fact before we pass on, that the Swan lamp is not referred to as an anticipation of the Gimingham.

The SOLICITOR-GENERAL: I was not aware that that was so. I presume your lordship will allow me, if necessary, to amend the particulars in that respect.

MR. MOULTON: I should say that they never detected that that was an anticipation until they came into court.

The SOLICITOR-GENERAL: Because we did not know what Gimingham's patent was. We never supposed it was anything so absurd as putting this into a socket. (To witness:) In the papers of M. Sidot he describes a way of making what he calls sticks of carbon, does he not?—Yes.

If anybody, following Sidot's directions, treated hemp, thread, cotton, paper and silk in the manner described, would he not obtain a carbon filament?—I think he would.

Suppose Swan had put one of Sidot's carbon filaments into his lamp, is there anything to prevent his doing so?—I know of nothing to prevent him doing it.

Would you not then have had a lamp that, according to your own description, would come within Edison's second claim?—I think it would.

Let me ask one question upon Gimingham's patent. The platinum sockets are continuous with the platinum wire, are they not?—They are.

Mr. JUSTICE BUTT: That is why, I suppose, he uses the words "formed directly." Mr. Swan's sockets were distinct ones; they were platinum, but they were attached.

Re-examined by Mr. MOULTON: Have you ever tried the experiment described in Sidot's paper?—No, I have never tried it.

It consists, as far as I understand it, of making the carbon in the presence of bisulphide of carbon?—It does.

And he describes the consequence of making it in this particular way that he gets a particularly sonorous carbon, hard and sonorous?—He does.

The SOLICITOR-GENERAL: And elastic?—Yes.

Mr. MOULTON: And it is a good conductor of electricity?—It is.

Would it, being a good conductor of electricity, be of advantage in an incandescent lamp?—Not if it was too good a conductor.

I mean "a good conductor of electricity." Does not that mean good for our purpose?—No, certainly not.

I want to connect it with the phrase that appears in some of the patents, "specific resistance." Is a good conductor one with high or low specific resistance?—A good conductor is one with low specific resistance.

The SOLICITOR-GENERAL: The carbon itself has great specific resistance. He is speaking of the difference between carbons.

Mr. MOULTON: He says it is a very good conductor. He says he has obtained analogous results with flax, hemp, cotton, paper, and silk. Beyond this paper you have no knowledge of what those results are?—No.

He speaks of pencils made with this carbon giving an electric light far more intense than the light one obtains with gas retort carbon. In your opinion, what electric light is he there referring to?—The arc light, I think.

In your opinion, has that part of the paper which refers to "becomes progressively incandescent throughout its mass without burning at any particular point like ordinary carbon, and it grows cold immediately you take it from the fire," anything to do with it when subjected to heat? Is that what he refers to?—"Pencils made from this give a more intense electric light." Is that the passage?

Yes. Then the next passage: "The conducting carbon." I suppose that is the translation?

The SOLICITOR-GENERAL: "This carbon conductor" is my translation.

Mr. MOULTON: With due respect, that is not the proper translation. The words are "*charbon conducteur.*" In one sense, "*conducteur*" is a substantive," and in the other an adjective.

Mr. JUSTICE BUTT: It seems to me that Mr. Moulton is quite right. They have turned the adjective into the substantive, and the substantive into the adjective. I do not know that it makes much difference.

Mr. MOULTON: It grows warm in the middle and becomes incandescent throughout its whole mass without setting fire at any particular point, like ordinary carbon. That refers to it when exposed to the action of fire. That is evidenced from what occurs immediately afterwards, that it gets cold when you take it away from the fire. Like a poker, it gets red hot along its length. It does not catch fire in its uniformity, but it has nothing to do with it under the action of electricity. It is a first rate conductor of heat. Therefore the heat passes along it, and it gets red hot throughout. And it is not like glass, which will melt at one point and be comparatively cold a little further off. He says it is different from other carbons by its great conductivity for heat and electricity. It is a question of interpretation. These conductors, when made incandescent by electricity, do not begin at one end as they do with ordinary heat; they begin all throughout equally. The words are: "*Dans la masse.*" It occurs progressively throughout its mass.

Mr. JUSTICE BUTT: How do you interpret the words "*Sans s'allumer sur un de ses points?*"

Mr. MOULTON: I think it means without burning, or without combustion. It gets cold immediately you take it away from the fire. He says it is exactly like, or "*a la façon de metal.*" I do not know whether I ought to ask the witness whether he agrees with that interpretation, but I believe it is the interpretation Dr. Hopkinson put upon it; and I am quite sure it is the correct interpretation. (To witness): Is that how you understand this passage?—I take it to mean what you have explained, that the carbon does not burst into flame or sparkle.

With regard to flexibility and elasticity, supposing anybody was to follow out the directions of this patent, in your opinion would the filament which he would use have sufficient flexibility and elasticity for the useful purpose you have described?—I think it would.

Turning to Pulvermacher's patent, is not the article which the patentee there proposes to manufacture an arc light composed of a central rod and a cylindrical rod wound round it?—I think it is.

Mr. JUSTICE BUTT: In Pulvermacher's patent the invention is —what?

Mr. MOULTON: It is the manufacture of carbon for an arc light, consisting of a central rod of carbon and another rod wound round it while soft, and then the whole is carbonised.—I think it is.

Mr. JUSTICE BUTT: The pencil is a rod of carbon. Then I suppose the matter which is wound round is not a carbon.

Mr. MOULTON: I ought not to have said carbon. It is something which is to be carbonised also. It seems to me to be lampblack and tar and a variety of things, mainly carbon, but some volatile elements to be driven off. If your lordship will kindly look at 2*r* you will see at the left hand side of it a thin line marked *j*. I find that *j* is what is called in the specification a thin core. (To witness): What is the size of the carbons you use for arc lighting?—They vary from 10 millimetres upwards—from 5 or 6 millimetres upwards.

Is the manufactured article here anything like a filament?—Nothing at all resembling it.

The central rod here was separated from the outside one by a non-conducting material, was it not? You will find it at line 22 of page 5 of the patent.—Yes.

"The pencil or rod should be previously coated with an insulating material." I believe that this compound electric candle was really a Jablochkoff's with one of the carbons spiralled?—I gather that it was something of that sort.

I do not know whether your lordship would like me to explain that the Jablochkoff consists of two carbons like that with china clay in between them—a non-conducting refractory material. (To witness): It is shaped in this way before it is carbonised?—It is.

And it is carbonised as one whole thing, and used in that way?—Yes.

In your opinion is there anything in it which would instruct the public to do what Edison claimed in his specification?—Absolutely nothing.

The SOLICITOR-GENERAL: If my friend chooses to ignore the point I cannot help it. My question was directed as to whether it was not the same material.

Mr. JUSTICE BUTT: I rather gather that Sir Frederick Bramwell in his evidence made a great point of this, that Mr. Edison carbonised his conductor after he had formed it, and that that was a matter not known or not in use before. But there is that much in Pulvermacher, is there not, that he carbonises after formation? Do you recollect Sir Frederick Bramwell's evidence on that point?—I do, my lord, only I understood Sir Frederick Bramwell to mean as applied to incandescent lamps.

Mr. JUSTICE BUTT: Well, that may be.

Mr. MOULTON: We do not contend, and it would be easily shown to be incorrect if we did, that in making such things as electrodes for arc lighting it was not known. The question is, the manufacture of a filament for a conductor for an incandescent lamp.

The SOLICITOR-GENERAL: I understood those gentlemen to say that there was no novelty in arc lighting. I did not pursue the subject.

Mr. JOHN IMRAY, engineer and patent agent, examined by Mr. Moulton, in reply to a question as to what he understood to be the invention claimed by Mr. Edison, in specification 4,576 of 1879, said he thought the whole thing was intended to substitute a carbon of high resistance for that which had been previously used, a carbon of high resistance in a convenient and useful form to make an incandescent lamp. Prior to this specification there was no practical carbon incandescent lamp in the market; many experiments had been made, but nothing had been practically or commercially successful. Before this date, Edison and others had made incandescent lamps by using very fine metallic wire. But this was subject to very great defects, and Edison here showed how to substitute for metallic wire a carbon wire, having the qualities of the metallic wire in the respect that it could be bent or turned back upon itself like a loop or in some such form, and by using a filament which was sufficiently flexible for the purpose before carbonising, and sufficiently stiff after carbonising, to solve that difficulty. The great advantage of having the burner in that form was this: first of all, it brought the two conducting wires very near to each other, so that they could be very easily sealed through the glass. Instead of having to carry the conductor round from one end of the globe to the other, you got both conductors at one place, with the result of what seemed to him most important of all, that from this form returning upon itself it gave freedom of contraction and expansion without straining the carbon at all. The advantage in substituting carbon burners for metal was, first of all, that you got a more highly resisting conductor, but, most of all, you got a more durable one.

Mr. MOULTON: Is there not a third and even more important advantage than both those, as to the temperature which it will stand?—Yes, no doubt, I meant to include that in the durability.

Has this patent, in your opinion, led to a commercial and practical lamp being made?—Yes; all the glow lamps that are now in use are practically of this kind.

Will you look at the four claims. Are any of those claims for things that were anticipated by any of the anticipations which are contained in the defendant's notice of objections?—No. I find taking the first claim that there is nothing that described a filament of carbon of high resistance sealed to a metallic wire.

The SOLICITOR-GENERAL: Made as described, or made in any way.

Mr. MOULTON: Now, the second claim.—There is no case of a carbon filament within a receiver, made entirely of glass, with

the air exhausted, the leading wire passing through the receiver. Then as to the third claim, there were coiled filaments or strips of metals, but there were no coiled filaments or strips of carbon as set forth. Then as to the fourth claim, it is a particular way of securing the wires to the filaments by putting in a large body of cementing material at the junctions, and carbonising, after putting it on. I find no anticipation of that.

In you opinion, is the practical value of this invention great?—Yes, I am sure it is.

Will you look at Scott's provisional specification. Is there enough in that specification, in your opinion, to show to you whether it relates to incandescent or to arc lighting?—To arc lighting, no doubt it does. He says so, as you will see if you look at the last sentence: "The electricity passes between the parts of the edges of the two hollow carbon cylinders which approach nearest to each other, those points being actually changed by the radiation of the hollow cylinders." That is one part. Then another part is on page 2, line 37.

The SOLICITOR-GENERAL: You may take that.

Mr. MOULTON: My learned friend admits it. Is there anything in that specification which, in your opinion, anticipates what is shown and claimed in Edison's, as you understand it?—No. The thing produced is for a very different purpose from Edison's, and on a very different scale. It does not suggest in any way a fine filament of carbon.

Mr. JUSTICE BUTT: I should like to know what is the smallest carbon conductor that you know of being used in the arc light?—I think you had better not ask me that, because I am not a practical lamp maker. Dr. Fleming could answer that, probably.

The SOLICITOR-GENERAL: I am told by one of our witnesses, who professes to be acquainted with it, and who no doubt is acquainted with it, that he has known it as small as the lead of a lead pencil.

Mr. MOULTON: I do not think the evidence which Dr. Hopkinson would give would be quite like that.

Mr. JUSTICE BUTT: I will ask Dr. Hopkinson afterwards. Dr. Hopkinson may say, "I never saw one thinner than what would be twice the thickness of an ordinary lead pencil." Then the Solicitor-General may call a gentleman who says, "I have seen one of the thickness of the lead of a pencil." And they will not contradict one another. But I should like to get, some time, what the real truth about it is, and what is the smallest arc light carbon conductor. I suppose the arc light conductors are all carbon.

Mr. MOULTON: They are all carbon. Of course the conductor wastes away there. But speaking generally?—Speaking generally, they run from a quarter of an inch upwards, but there are some made for chemical experiments and otherwise which are smaller.

Mr. JUSTICE BUTT: I mean in use as lamps?—I should think the very smallest would be an eighth of an inch in diameter.

Mr. MOULTON: Have not the Jablochkoff candles as small carbons as any?—Yes; I think it is from an eight of an inch to a quarter of an inch.

Are these much larger than those used for electric incandescent conductors?—Oh yes; those are very fine indeed.

In arc lights is it an advantage to have a high resistance in the carbons?—No; you want the carbon a good conductor in that case.

The light is not produced, is it, by heat generated by resistance?—No, except the resistance of the space between one carbon and the other; not of the carbon itself.

Will you take the next specification, Harrison's. Is this a practical specification for anything?—I think not. He proposes to use gun cotton as a core.

Apart from the fundamental absurdity of using gun cotton, is there anything there which can possibly suggest a good conductor for an incandescent lamp?—No, certainly not.

He suggests also plating, by electrotyping on metal. Would the result of that be a good conductor which could be used?—No. It is all evidently intended for arc lighting.

I do not want to lead you, but in your opinion is that specification utter nonsense?—I do not think it is far short of it.

The SOLICITOR-GENERAL: That is rather strong, quite apart from the irregularity.

Mr. JUSTICE BUTT: Mr. Harrison might object to that.

Mr. MOULTON (to witness): Will you kindly turn to Sidot. Would you just tell me what in your opinion is the object of that paper?—It is an account of experiments in precipitating carbon from a gas or vapour containing carbon by applying heat and thereby producing a sort of coke something like the graphite that is formed in gas retorts.

I do not know whether you have heard of its being practically applied at all?—No. The same sort of thing occurs in gas retorts—a deposit of graphite.

It is simply to make a form of coke. Will you look at the passage beginning "*Les crayons qu'on en compose?*"—It evidently means there are crayons, crayons for the arc light, because there was no incandescent light known at this time. That is, at the time this was written.

What is the ordinary meaning of "*Les crayons qu'on en compose douent une lumiere electrique beaucoup plus intense que la lumiere que l'on obtient avec le charbon des cornues á gaz*" in 1870?—Entirely the arc light.

The phrase "electric light" was a well-known phrase at that time?—Yes, perfectly well known.

Then go to the latter part of that paragraph, "*Le charbon conducteur s'échauffe à la facon d'un metal.*" What do you understand by that?—That sort of carbon which is highly conductive of heat and becomes heated like metal when you apply heat to it, not like ordinary carbons. That is to say, the heat pervades it, it being a good conductor of heat, instead of all gathering at one point.

Do the words that follow support that meaning?—Yes, it becomes light all throughout its mass without becoming extremely hot at one point.

The SOLICITOR-GENERAL: Becomes extremely light, "*S'illuminer.*"—Not necessarily; becomes light.

Mr. MOULTON: Could the words apply to its behaviour in heating by electricity?—No, because at the end of the sentence it says that it becomes cold as soon as you take it out of the fire.

Would it be true that that is characteristic of ordinary carbon under the influence of the electric current?—No.

Do electric currents make progression from point to point?—No; they flash all over.

At the very end there is a statement that the carbon referred to there presents itself in long filaments of one centimetre long?—Yes.

That is something like the filaments of wood less than half an inch long?—Yes.

Does that point to anything, in your opinion, which would at all anticipate anything in Edison's specification?—No. It means that there is a series of beads deposited joining one another—what is called a filament of beads, or a string of beads.

Would that be a sort of filament which would be at all useful?—I do not think it would.

Would the inequalities of the string of beads be especially disadvantageous?—Yes. You might have a few bright points between bead and bead, but the beads themselves would not be bright.

You remember the lamp made by Mr. Swan prior to the date of this patent. Were you present when Dr. Hopkinson gave his evidence with regard to that?—Yes.

Do you agree with him?—Yes; it is distinctly a rod of carbon. It is as near as possible, I should say, the twenty-fifth of an inch in diameter, and about an inch long, from socket to socket.

In your opinion, would that lamp teach the public what is described and claimed in Edison's specification?—Oh, no; I should think that that lamp is not at all fitted for incandescence, because of the very large conducting power throughout.

To the best of your knowledge, did that, as a fact, lead to the manufacture of any practical lamps?—Not that I ever heard of.

Will you kindly take the specification of Mr. Swan's of 1880, No. 18, and will you tell us also what invention you find there described and claimed, as you understand?—A means of getting rid of the very last particle of air or gas from the carbon of a glowing lamp by heating it by the electric current while the pump is making a vacuum. As far as I know, Mr. Swan was the first to apply this process to a carbon incandescent lamp.

Would you kindly look at Edison's specification 2,402, of 1879, page 11. In that specification, what kind of lamp is Edison dealing with?—He is dealing mostly with lamps in which metal wires are used.

It does not deal with the carbon incandescent lamp at all?—No, not all.

So far as you understand that specification, do you see any directions in it for making or improving a carbon incandescent lamp, or any indications as to anything that would be useful for that purpose?—No. He says in one sentence that you may apply to carbon sticks the process which he describes for wires, to free them from air. But he gives no directions how to do it with carbon filaments within an exhausted receiver.

The platinum is actually fused together by the process, in the platinum lamp, is it not?—He says so.

He says carbon sticks may also be freed from air. I ask whether he there points to an operation by which carbon is raised almost to the melting point, and, as it were, fused together?—Yes. It is raised to a temperature at which it becomes pasty.

Does he in any way suggest any treatment of carbon excepting that which thus makes it homogeneous and hard by almost fusing it together?—No.

The SOLICITOR-GENERAL: We have the words before us. He says, "may be freed from air."

Mr. MOULTON: I know that, Mr. Solicitor-General, and I am asking whether he suggested any treatment of carbon excepting that by which the air is driven out and it is fused together?—His object evidently was to condense the carbon.

Is there any suggestion in this patent as to using those sticks in incandescent lamps?—No, there is not. I understand it to mean sticks used for the arc lamps.

He, I believe, applies the method that he has been describing actually to improving the material of platinum, does he not?—Yes.

In your opinion, was this application to carbon sticks in order to make an improved material, or was it at all in connection with any special use of the carbon?—I take it to have been the condensing of the carbon.

Will you kindly look at Swan's specification of 1880, No. 18. Has the operation, as described by Mr. Swan, for its object the condensation of the carbon?—No; it is entirely to get rid of the occluded gases and air.

Is the operation described in Swan's patent, either as practically used, or as described, at all an operation that renders the carbon pasty or fuses it together in that way?—No; not at all. I cannot say that I have ever seen carbon heated so far as to be pasty; I have read some accounts of it, but I have never seen it, and it is not suggested here.

I do not know whether you are prepared to say whether a filament would stand such an operation as is described, which renders it pasty?—I doubt whether it would stand it. If it was soft, I think its own weight would bend it or break it down.

I do not know whether you know whether or not the carbon is rendered by this process, as applied to filament lamps, in any way more homogeneous?—No. It seems to give it a better, a smoother and brighter surface; that seems to be all that is done to it.

In your opinion, would Edison's prior patent of 1879, No. 2,402, teach the public how to use Mr. Swan's process in the manufacture of a carbon incandescent lamp?—No, I think not. It requires some invention to take the steps that Mr. Swan took.

As a matter of fact, is that process, as described by Mr. Swan, in universal use?—I believe it is universal.

Turning to Mr. Gimingham's patent, is that a patent which in your opinion explains sufficiently the way in which the invention of the patentee is to be carried out?—Oh yes; it is very clear.

In your opinion is that a useful invention?—Yes; it is very useful for this reason, that it gets the socket which holds the carbon in one piece to the conductor. That is a very great advantage, because every way of fastening the socket, by solder or otherwise, is liable to give way by reason of the great heat.

Do you know of any anticipation of this prior to the date of the patent?—No, Of course, I know that things have been held in sockets, but I do not know any case where it is held in the socket in the same piece as the wire.

You are speaking of electric incandescent lamps?—Yes; because in that lamp of Mr. Swan's I see the carbon is held in the socket and that socket seems to be fixed to the wire by some other thing, solder or something.

Is there any special reason why incandescent lamps should have as few and as simple junctions as possible?—Yes; the joints are the weak points. If there is a slight break of continuity at the joints of course the greatest heat will develop itself there, and that will destroy the carbon at the joints.

Bodies behave differently under heat?—Yes. There are different degrees of expansion and contraction, so that there is a continual loosening of these joints when they are made of different pieces.

Mr. JUSTICE BUTT: Suppose that you have platinum socket and wire?—There would be a difference, owing to the form. A socket would not expand or contract to the same extent as a wire would.

Cross-examined by the SOLICITOR-GENERAL: I suppose you have seen a point fitting into a socket before, have you not?—Yes.

There is no novelty in that?—No, I said so.

There is no novelty in the manufacture of the socket, the flattening of the wire and drawing it through a draw-plate?—I do not think I have ever seen it. I cannot recollect it.

Have you ever seen Gimingham's pure and simple applied practically?—I never particularly observed whether it is pure and simple. It is impossible on that small scale to see exactly what it is on mere examination.

You cannot tell me from your experience whether Gimingham's without the application of some mechanical pressure to squeeze the carbon and platinum together, has ever been used?—I think that very naturally he would squeeze it. Being an open pipe or socket, one would naturally squeeze it.

Will you tell me from your experience whether you would be able to use Gimingham's in any other way?—I should most likely have to squeeze it a little. That is exactly what I should think the specification would tell.

Do you find in the specification anything about squeezing?—No.

Then please do not put things upon me. I ask you whether you find in the specification anything about squeezing the socket?—Yes, I read this, that by the combined spring of the metallic and tubular parts the carbon is fixed firmly.

I may be very stupid, but I do not see one word there about applying mechanical force to the compression of the socket?—Not when you speak of mechanical force. The mere squeezing between the finger and thumb is sufficient.

Does he not, on the contrary, tell you that it is gripped sufficiently by the combined spring of the carbon itself and the metal tube?—Yes.

Does not that, to your mind, indicate that he did not intend that mechanical force, either pressure of the fingers or by a pair of nippers, or anything of that kind, would be necessary?—No, it indicated to me that it must have some pressure, or otherwise he could not have caught the spring.

I will ask you about Swan's specification, of 1880. The practical point of that patent is this, is it not, that in order to get rid of the occluded gases which were found remaining in the carbon, however good the vacuum was made, he passed an electric current through the burner while the air pump was still running?—Yes, in order to make the vacuum more complete.

And the heat brought out the occluded gases in the carbon, did it not?—Yes; and no doubt from the rest of the bulb.

Do you not find in the first part of Edison's specification, 2,402, an exactly similar process applied, though with more detail, to an incandescent lamp with a metallic wire burner?—Yes.

And his object is to free the occluded air and gas, and to obtain a more perfect vacuum?—Yes, that is one of his objects, but there is a second object.

Then when he comes to "carbon sticks may be also freed from air in this manner," have you any doubt whatever that he is speaking of carbon sticks used as conductors in incandescent lamps?—Yes, I doubt that, because I do not know of any incandescent lamp in which carbon sticks are used.

I am not asking you that. Have you any doubt that when he describes a mode by which the metal conductors of an incandescent lamp can be freed from air before the lamp is sealed, and then says "carbon sticks may be also freed from air in this manner," he means to treat the carbon sticks in exactly the same way as he treated the wire conductor?—No; carbon sticks used in arc lamps.

Do you find a single word in that specification about arc lights?—No; but I judge from the context. He calls them sticks, and he does not claim them.

You have told me that in the earlier part, in which he describes a process of freeing the metal conductors of air, he is speaking exclusively of an incandescent lamp; and then you told me that when he says "carbon sticks may be also freed from air in this manner," he is not speaking of an incandescent lamp?—I think not.

How can you, except in an incandescent lamp, free the carbon sticks or carbon candles from air in the manner described, that is, by running the pumps after you have passed a stream of electricity through the conductor before the sealing up process?—When he wants to free a carbon stick from occluded gases, and make the surface pasty, he puts it, or any number of them, into an air-tight case, heats them by the passage of a current of electricity through them, while he keeps the vacuum going, and then, after that, he can take them out and use them in arc lamps.

Then he does, in order to free them from air, propose to place them in a close receiver?—In any close vessel.

He says "in the same manner" in a close vessel, not entirely closed, with the pump still running, and passing a stream of electricity through the carbon stick?—Yes.

Would not that be exactly Swan's process in regard to the carbon conductor?—It is very much the same process.

Do you see any difference?—Yes. Edison carries the heat much further. He wants to make them pasty.

Except that Edison proposes to have a higher heat can you suggest that there is any difference?—No, not except that.

Would there be any object in freeing the carbon sticks from air unless they were to be used in an incandescent vacuum lamp?—Yes. You may have for certain arc lights a good conducting power and great density.

Would not exposure to the atmosphere bring back the occluded gases?—Not if you had got your surface partly fused.

Would it to a partial extent?—To a partial extent it would, no doubt.

Therefore you would not free it from air? Do you know that any human being, in or out of his senses, has ever used this process of Edison's for the purpose of preparing carbon sticks for arc lamps?—I do not know that any one has.

Suppose that you have a description of a process of these platinum conductors, or metal conductors in an incandescent lamp, Edison's process, in fact, do you suggest that there would be any difficulty in applying that process to a carbon conductor?—There would be no difficulty in applying it.

(To be continued.)

NOTES.

Electric Lighting of the Folkestone Exhibition.—The electric lighting of the Exhibition of National Art Treasures at Folkestone, opened on the 22nd ult., has been entrusted to the Electrical Power Storage Company, and is one of the most interesting features of the exhibition. The whole installation has been designed by the engineers of the company as a model of a large electric lighting station, such as would be required for the lighting of a town, and both arc and incandescent systems are represented. The arrangements made enable the different groups of arc lamps to be turned on and off at will without the remaining lamps being in any way affected, and by means of the E.P.S. accumulators, a total extinction of the incandescent lamps is rendered practically impossible. As a further safeguard, the whole plant has been sub-divided, and each of the galleries and other departments is supplied from two separate and distinct circuits. Two sets of E.P.S. batteries, in glass boxes, and of the newest type, containing 31 plates in each box, are charged in the daytime, and kept as a reserve. There are in all 36 arc lamps, each giving a light of 3,000 candles, and 1,250 incandescents of 10 candle-power. The arc lamps are fixed outside for the lighting of the gardens and entrance to the exhibition, and are also suspended from the roof in the central nave, which is very brilliantly illuminated at night. The power is supplied from two Marshall engines, each giving 80 horse-power, this being transmitted by means of counter-shafts to four Crompton dynamos, which supply all

the current for both arc and incandescent lamps. There has, up to the present, been no public exhibition for lighting which has been so carefully worked out in all its details, and electricians will doubtless find much of the apparatus well worthy of their inspection. The whole of the electric light machinery and appliances for the generation of the current are contained in a building separate from the galleries of the exhibition, being connected only by a covered way for the convenience of visitors who may desire to inspect them. This also applies to the refreshment rooms of Messrs. Spiers and Pond, for whom a similar covered way has been provided.

The lighting of the exhibition was successfully completed before the opening day; the lights being run up to one o'clock on several nights to facilitate the hanging of the pictures. The mode of lighting selected for the different parts of the building is reported to give satisfactory results, and it is proposed to utilise the building as a permanent winter resort after the closing of the exhibition, when, doubtless, the apparatus of the Electrical Power Storage Company will be retained.

Electric Lighting of Ships.—In an article on the navigation of the Suez Canal by the electric light at night, the *Shipping and Mercantile Gazette* expresses the opinion that the electric light is an expensive luxury on board ship, and says it doubts very much whether the directors of the Peninsular and Oriental Company (whose ship, the *Carthage*, has been used in the recent experiments) would care to have their whole fleet fitted with the necessary appliances to enable them to pass through the Suez Canal at night with the aid of the electric light.

Electric Lighting in a Tobacco Manufactory.—Messrs. Mather and Platt have recently completed an installation of 700 lamps in the extensive new tobacco and cigar manufactory of Messrs. W. D. & H. O. Wills, Bristol. No gas has been laid on, except for heating purposes. Two 500-lamp Edison-Hopkinson dynamos, running at a speed of 700 revolutions per minute, have been supplied for this installation, either of which is capable of maintaining the whole number of lamps in use at one time.

Electric Light Installations in France.—Some very interesting statistics up to date of May 1st have been compiled and published in the *Bulletin International De L'Electricité* for May 31st. We cannot afford the space to recapitulate the details therein mentioned, but a summary is given in the following table :—

	Number of installations.	Number of arc lamps.	Number of incandescence lamps.
Public roads	10	108	140
Public buildings	5	...	1,487
Theatres	14	324	3,244
Ships	25	52	5,947
Special houses	28	98	1,594
Shops, Cafés	49	762	3,932
Museums	3	2	800
Workshops, factories	895	4,163	33,537
Timber yards for public works ...	8	61	10
Central stations	7	...	4,630
Photo-electric apparatus	...	300	...
	1,044	5,880	55,321

The above figures although not absolutely complete, some few houses having failed to give the information demanded, are sufficiently accurate to enable one to form a very fair estimate of the state of electric lighting in France. In addition to this we observe that there are 42 installations for the electrical transmission of power, 310 horse-power being employed, the Gramme machines used therefor numbering no less than 190.

The Electric Light at Lloyds.—The printing department at Lloyds has now been fitted with the electric light by the Electrical Power Storage Company.

Temporary Electric Lighting.—On the 26th and 29th May the Indian Room at Marlboro' House was again lit throughout by the electric light, the installation being, as before, carried out by the Electrical Power Storage Company. The company also carried out on the 26th an installation of over 100 lights of 20 candle power at Dover House, which was repeated on the 29th.

The Albert Palace.—The electric lighting for this palace is, we are informed, to be on an extensive scale. A large open air theatre is being erected in the grounds in imitation of the Cafés Chantants of Paris, and among other attractions there will be a first class ballet. The front of the proscenium is to be illuminated by a double row of incandescent lamps, while a powerful arc light is to be placed on the top of the band stand opposite and directed on to the stage. The band stand itself is to be converted into a royal box. A number of tall venetian masts are to be placed in the grounds, having an arc lamp on the top of each, while from post to post and thence to the top of the band stand thousands of coloured incandescent lamps are to be suspended in festoons, the effect of which will no doubt be very pretty. The interior of the palace itself will be lighted during the summer months with arc lamps, to which are to be added some two thousand incandescent lamps during the winter when the outdoor attractions are over. A new and capacious engine house is in course of erection, and the Jablochkoff Company which has taken the contract for the lighting, has arranged with Messrs. Hornsby & Sons to supply two powerful steam engines with all latest improvements.

The Cost of Electric Lighting in Vienna.—According to published details of the cost of electric lighting at the Arcade Buildings of the Union Building Association in Vienna, a 16 candle Edison lamp costs, on the whole, 0·518d. per hour; while a gas jet costs, on the whole (including interest, &c., and the gas being at 4s. 6d.,) 0·338d.

The Electric Lighting Bills. The Select House of Lords Committee on the Electric Lighting Act Amendment Bills are still proceeding with their enquiry, and still sitting with doors absolutely closed to all but themselves, the shorthand writers, and such witnesses as they summon.

Establishment of a Telephone Exchange at Gibraltar.—Advices from Gibraltar state that Messrs. Spagnoletti and Crookes have issued a circular informing the public that they have been granted a concession for the erection of a telephone exchange in Gibraltar, to which they invite subscriptions. For the benefit of the trading community they propose to open an office on the wharf. The system is to be the same as that employed in England, and as the subscription has been fixed at the moderate sum of £10 it is anticipated that the venture will prove a great success. Telephonic communication will certainly prove a great boon in Gibraltar.

The Telephone at Athletic Meetings.—An application of the telephone which, from its promise of great usefulness, should receive considerable development elsewhere, was witnessed at the Darlington Athletic Sports last Saturday. A Byng acoustic telephone was fitted up by Mr. E. Cox-Walker to establish communication between the competitors' dressing room and the centre of the field, and by this means a great deal of time was saved previous to each race in "telegraphing" the numbers of the competitors about to run. The authorities at Stamford Bridge might, with advantage, make a note of this.

Telephone Exhibits at the Edinburgh Exhibition.—We have received from the National Telephone Company a descriptive catalogue of the company's exhibits at the Edinburgh International Exhibition. This catalogue contains eight pages of small type and describes no less than 45 instruments.

The Portsmouth Telephone Exchange. — The Admiralty has granted permission to the Western Counties and South Wales Telephone Company to connect the torpedo school ship in Portsmouth Harbour with the telephone exchange. It is anticipated that this will prove a great boon, as the *Vernon* is in communication with the other harbour vessels and subscribers will be able to speak through to them. The members of the Royal Naval Club will, no doubt, find this extremely convenient. Considerable progress has been made of late in connection with the exchange, and it is probable that before very long a hundred members will be on the books. There is plenty of scope for future work in the district. For instance, telephonic communication with Gosport, which is separated from Portsmouth only by the breadth of the harbour, might before long be acceptable to the inhabitants generally, and particularly to those engaged in business pursuits.

Conference of Telegraph Clerks.—The annual conference of telegraph clerks was held at Swansea on Saturday, 24 delegates from important towns being present. Several matters connected with the status and interests of the telegraphic profession were discussed, the conference lasting seven hours. The questions of payment for Sunday duty and annual holidays were brought forward, and a determination expressed resolutely to urge reform. Letters were read from a large number of M.Ps. expressing sympathy and support. A resolution was passed thanking Mr. Saunders, Lord Claud Hamilton, and other members of Parliament who had undertaken to promote the claims of the provincial telegraph clerks for Sunday pay. The Swansea staff entertained the delegates to a dinner in the evening.

Telegraph Receipts.—The receipts on the telegraph service from April 1st to May 22nd, 1886, amounted to £200,000, against £210,000 received from April 1st to May 23rd, 1885; from April 1st to May 29th, 1886, £265,000, against £280,000, from April 1st to May 30th, 1885.

Cable Companies' Receipts.—In an article dealing primarily with the contest between the Atlantic cables, the *Financial News* gives the following statistics to show that the traffic receipts of cable companies generally are decreasing. The Atlantic companies publish neither weekly nor monthly returns, so their receipts are not included :—

Traffic Receipts of the Undermentioned Submarine Cable Companies for the last Three Months.

	1886.	1885.	Monthly decrease.	Quarterly decrease.	Annual decrease at same rate.	Per cent. of decrease on capital.	Dividends paid, 1885.
Cuba Submarine.	£	£	£	£	£	Per cent.	Per cent.
Capital £160,00.							
February ...	2,750	2,730	+ 20				
March	3,300	3,510	−210				
April	3,300	3,886	−586	776	3,104	2	8½
Eastern.							
Capital £3,800,000.							
February ...	48,814	61,784	12,970				
March	53,016	68,296	15,280				
April	47,611	63,085	15,474	43,724	174,896	4¾	6
Eastern Extension							
Capital £2,500,000.							
February ...	33,688	40,114	6,426				
March	37,804	46,193	8,389				
April	34,292	41,233	6,941	21,756	87,024	3½	7
Great Northern.							
Capital £1,500,000.							
February ...	18,800	20,400	1,600				
March	20,000	22,800	2,800				
April	19,800	25,200	5,400	9,800	39,200	2½	8

West African Cables.—The Silvertown Company's cable ships, the *Dacia* and the *Buccaneer*, left the Thames on May 22nd, bound for the West Coast of Africa, and carrying cable for the extension of the West African Telegraph Company's system along the coast. The first object of the expedition will be to connect Bathurst with the Cape Verde Islands. This work will be on behalf of the African Direct Telegraph Company. The ships will then proceed to lay a section for the West African Telegraph Company between Sierra Leone and Konakri, which latter place the Silvertown Company has already placed in telegraph communication with Europe. The heavy cables for the landing places at Grand Bassam, Accra, and probably Porto Novo will then be laid. The ss. *Silvertown* will sail towards the end of this month with sufficient cable to connect up the above-mentioned places, and to continue the West African Telegraph Company's system to S. Thomé, Principe, Gaboon, and S. Paulo de Loanda. The Telegraph Construction and Maintenance Company are sending out their *Britannia* and *Scotia* to continue the African direct cables from Bathurst to Sierra Leone, thus duplicating the West African Telegraph Company's cables to the latter place. These ships will then connect Sierra Leone with Accra. This section will serve as a common line for the West African Telegraph Company, and the African Direct Telegraph Company. From Accra the cables will be continued to Lagos and the mouths of the Niger. We understand that as the *Scotia* will be obliged to make two trips, the Colonial Office has granted an extension of time to the Telegraph Construction and Maintenance Company for the completion of their work. The *Dacia* left Lisbon on May 29th, after taking on board the representative of the Portuguese Government, Captain E. Vasconcellos, of the Portuguese Navy. The *Buccaneer* arrived at St. Vincent on June 1st, en route for Sao Thiago and Bathurst, at which latter place she will rendezvous with the *Dacia*.

The Incandescent Lamp Underground.—An interesting application of the electric incandescent light to mining operations recently took place at Lord Vernon's Poynton and Worth Colliery, near Stockport. The lower pump rod of the main pumping shaft of the Lady Pit, by which the pits are drained, broke, leaving the bucket in the bottom some 600 feet below, and submerged in water. To remedy the rupture, divers were employed, and their operations were carried on by the light of a Siebe diver's electric lantern worked by Thame's primary battery. The Siebe lantern is a strong appliance and weighs some 83 lbs. out of water. It consists of an iron cover permitting the conductors to pass inside to a cluster of four incandescent lamps, the light of which is reflected downwards by a white reflector in the roof. A stout glass globe encircles these, and is protected from injury by iron prongs around it. Fifteen cells of Thame's primary battery were employed, and the total light obtained was about 80 candles, a luminous sphere of some 6 feet in radius being obtained under water. Mr. Thame has designed a small hand lamp supplied by four cells of his battery within the lantern, which is now used in the ether chambers of brewers. It is of the utmost importance that this lamp should be safe and free from any liability to cause explosion of the ether. It is carried into the chamber by the operatives; and we understand that Colonel Majendie has expressed his approval of the lamp for use in gunpowder works and magazines.

The Colonial and Indian Exhibition.—One of the two Fridays for which the right of excluding the public has been reserved by the Royal Commission for the Colonial and Indian Exhibition, has been allotted to the Society of Arts for their Annual Conversazione, which will be given at the Exhibition on Friday, July 16th. Arrangements have been made for the purchase, by members of the Society only, of tickets to the *fête*, on the same system as that which was adopted last year.

Secondary Battery Patents. — A correspondent writes :—"I should be glad if any of your readers can inform me whether there is any infringement of Sellon-Volckmar's patent for secondary batteries by the B.T.K. batteries, and whether the E.P.S. can have any claim against persons using them for electrical purposes."

How to Elude Payment.—A case relating to incandescent lamps occupied the attention of the judge in the City of London Court last week, the contesting parties being Messrs. Shippey Brothers and the Jablochkoff and General Electricity Company. Messrs. Shippey claimed to have supplied the company with a number of crystal incandescent lamps, for which they sought to recover £5 15s. 6d. The answer to the case was that the company was not incorporated at the time the lamps were supplied, and that the wrong parties had been sued. It was stated that the goods were sold to the old company, and transferred by agreement to the new company, at the liquidation of the former. The lamps were exhibited at the Inventions Exhibition, and the Jablochkoff Company was awarded a silver medal for them. The judge said some rather sharp things regarding the affair, amongst others that it appeared to him that the whole thing was a juggle between the old company and the new one, and eventually he adjourned the case for the production of the liquidator's list.

The Strange History of a Dynamo.—We take the following from the *Telegraphist*:—Those of our readers who know little or nothing of the evolution of the dynamo, from the immortal discovery of Œrsted to the latest type of machine, will do well to study "The Strange History of a Dynamo as told by itself to A. Dynamicable" now being published in our esteemed contemporary the ELECTRICAL REVIEW. The author writes in a popular and almost humorous style. He avoids technicalities and mathematics, the diagrams are unmistakable, and it is clear that the Dynamicable, whoever he may be, thoroughly understands his subject. The first article appeared in No. 438, vol. 18, April 9th, and they will be continued every week. The proprietors of the ELECTRICAL REVIEW will do well to publish "The Strange History of a Dynamo" in book form at a popular price. It would be certain to have a large sale.

A Salutary Reprimand. — At the Thames Police Court last week, Messrs. Edwin Fox, of the Magnetic Telegraph Works, Westferry Road, Millwall, were summoned for committing a breach of the regulations of the Floods Act, by omitting to have a movable tide board fixed in its place. Mr. Lushington observed that by such neglect an immense amount of damage might be caused, and the defendants would have to pay a fine of £5.

Electrical Conferences.—The next electric light convention in the States will be held on August 31st, at Detroit, and the next telephone convention, on September 7th, at St. Louis.

Silicium Bronze Wire.—The employment of this wire for telephonic purposes has proved very satisfactory; in several cases, spans have been carried right over chimneys close to chemical factories, and have stood for four years without being affected; whereas galvanised iron, under like conditions, has rotted away in a year. The only effect of the chemical fumes on the bronze is to cause a thin coat of oxide to form on the surface. The 1·1 millimetre wire, which is in general use, weighs 8·47 kilogrammes per kilometre, and has an average breaking strain of 84 kilogrammes per square millimetre of section. The conductivity is about 43 per cent. of pure copper.

Dynamite Accident.—A serious accident occurred recently on board the *Nettle*, in Portsmouth Harbour. Some experiments had just been concluded in testing cables by means of dynamite cartridges, and the workmen emerged from their places of shelter in order to shift the cables. At this moment a canister of dynamite, believed to have previously hung fire, suddenly exploded with a loud report, and severely injured a shipwright, named John Lewis, who was standing near. He was conveyed to Haslar Hospital.

Change of Name.—We are asked to state that the firm of Cordner, Allen & Company, Limited, has changed its title to the Stanhope Company, Limited, by which name the company will henceforth be known. Mr. W. J. Cordner has retired from the company, the present directors being Messrs. James Ashworth, T. M. Collet and John S. Sawrey.

The Recent Thunderstorm.—A correspondent, subscribing himself C. G. H., writes under date May 24th to the *Morning Post* as follows:—"A sycamore tree was struck by lightning in the severe storm yesterday morning, at 8 a.m., although it stands only 30 yards from the spire of our church, on which there is a good copper conductor. Is not this unusual? The effect upon the tree was singular, merely to strip the loose bark from its trunk, and one limb, and scatter it about with a shower of leaves. Also an oaken fence, which is nailed to the tree, has its second upright split from top to bottom; the fifth one on the same side has a piece of some 18 inches long and 2 broad torn completely off and thrown across the road; no other part of the fence suffered in the least. I may add, that some years ago, 100 yards from this spot, the smallest of some Lombardy poplars was struck, the finest tree within three yards of it escaping. Also a Huntingdon elm standing on the edge of a pond close by these poplars has been struck by lightning no less than three separate times, and still survives."

Another correspondent writes under date May 25th: "With reference to the letter of 'C. G. H.' in your issue of to-day, I can give an almost parallel case to that he mentions. A few years ago a lime tree on my lawn, some 60 yards from the church spire, which is 175 feet high, and on which there is a good copper conductor, was struck by lightning. In this case the effect upon the tree was as singular as that mentioned by your correspondent—viz., merely to strip the bark from the lower part of the trunk and scatter it in innumerable fine shreds within a circumference of about 15 yards. The tree still survives, but alas, our favourite cat, which had taken refuge under a seat at the foot of the tree, was killed. P.S.—Before the conductor was fixed, the tower on our church was struck by lightning and much shaken."

Electrical Purification of Copper. — Messrs. Sir Hussey Vivian & Sons, of Swansea, about a month ago, purchased from Messrs. Mather & Platt, through the Edison and Swan Company, one of the largest dynamos hitherto constructed for electrolytic purposes. It has an output of 50 volts and 1,000 amperes, at a speed of 400 revs. The weight of the entire machine is 5¼ tons. The magnet limbs are solid forgings, each weighing 22 cwt., and are shunt wound only, each limb having 260 lbs. of copper wire. The armature is constructed of bars, 0·338 square inch area, and has a resistance as low as 0·0016 ohm. The commercial efficiency of the machine is over 93 per cent. This dynamo has given such satisfaction that Messrs. Mather & Platt have recently received an order from the same firm for a second precisely similar machine.

Goubet's Submarine Boat.—Those of our readers desirous of further information respecting this vessel can find a detailed description in *La Nature* for May 8th last.

The Shortest Way to a Funeral.—The system of electrical intercommunication between passengers and railway officials devised by Mr. S. A. Varley, is in operation on the Hull and Barnsley Railway. We have just seen a letter from one of the guards on this line to a friend. The following extract is unique of its kind:—"I must tell you the communicator acts very well. I will just give you an instance. The other day, just as we got to Ouse Bridge someone pulls the bell; we stopped. As soon as the train stopped a man jumped out, runs down the bank, and I thought he was going to jump in the river. You would have laughed to have seen him run and me after him. He was going to a funeral and he thought that was the nearest place to get off; not a bad cheek, had he?"

Cut-outs for Arc Lamps.—The Woodhouse and Rawson Electric Manufacturing Company specially designed and made a number of cut-outs for the large arc lamps at the Colonial and Indian Exhibition. They are arranged to cut out the lamps with which they are connected if anything goes wrong, and to insert a resistance in the circuit equivalent to that of the arc, retaining all the time the continuity of the circuit and not putting out the rest of the lamps in circuit. They consist of an electro-magnet of double T shape, with a "bridge" armature which carries a copper horseshoe dipping into two mercury cups. The magnet is in the lamp circuit, and holds up the armature and breaks connection between the mercury cups if everything is working satisfactorily; but if the lamp goes out from any cause the armature drops and connects the mercury cups, thus putting in the equivalent resistance, which remains until the current passes through the lamp again. This arrangement appears to be precisely similar to that employed by the late Richard Werdermann in 1878 when using his semi-incandescent lamps in series.

Through the Telephone.—For a faithful representation of the difficulties attendant upon telephoning we would call attention to *Punch* of May 15th. We could almost imagine that the "scientific farce" in our lively contemporary had been compiled from our own sad experiences.

The Electric Light a Failure Everywhere!—At a meeting of the Monte Videan Gas Company last week, the chairman stated that a proposition had been made by the board to the Government of the Principality, and if the scheme should be carried out, as he thought there was every probability that it would, they might look forward to a bright and prosperous future. The proposition was made some time before the electric light scare in the principality. Many of them had no doubt heard of the rumours with regard to the electric light there. An individual hailing from Buenos Ayres thought it would be a very good stroke of business to palm off some second-hand electric lighting plant, which was rusting in some part of the Municipality, on the Government. Unhappily the authorities fell into the net, but they said it was simply a little experiment, and that there was no meaning in it. The board heard by the last report that the whole thing had been quashed, so that he hoped they would hear nothing more about the matter. Their manager had protested at the proper time, and the board thought that he had done a very great service, not only to the company, but also to the Municipality, in saving them from embarking in a concern that would ultimately end in a fiasco. The board, if they had liked, could have established their own electric lighting plant there, but they had not done so, as they felt that it would be throwing money away in an experiment which would be fated to fail. Article 18 of the concession gave them power to adopt, with the concurrence of the Municipality, any new process or scientific discovery of any other light-producing agent superior to gas; therefore it would be seen that no one had a right to interfere with the power they had in the matter. The electric lighting of cities had been a failure in every part of the world.

Schanschieff's Battery.—In an editorial article in the *Exchange and Mart* for the 12th ult., we notice the following amongst many other inaccuracies respecting this battery:—"The consumption of zinc is but 1 lb. per horse-power hour." We wonder where the editor of our contemporary obtained this information? Not from the inventor himself, we feel sure; therefore it must have been evolved from the writer's inner consciousness.

Incandescent Lamp Patents.—A glance at our Correspondence columns will show how a practical manufacturer of incandescent lamps would have answered certain of the questions put during the late trial.

NEW COMPANY REGISTERED.

Loeb Chemical Electric Light Company, Limited.—Capital £4,000 in £1 shares. Objects: to purchase and work the letters patent which have been applied for by Leon Napoleon Loeb, for the invention of a primary battery. The provisional specifications are numbered 2,647 and 2,648. Signatories: *J. S. Burroughes, 19 Soho Square, 850 shares; *Walter Buttery, 5, Pemberton Gardens, Holloway, 100 shares; F. J. Burt, 72, Cornhill, 10 shares; F. R. Miller, 72, Cornhill, 10 shares; W. J. Crump, 10, Philpot Lane, E.C., 10 shares; R. Plumbe, 13, Fitzroy Square, 10 shares; J. Sherbrooke, 9, Gracechurch Street, 10 shares. Directing qualification, 100 shares. The company in general meeting will appoint remuneration. Registered 26th ult. by Messrs. W. A. Crump and Son, 10, Philpot Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Loeb Chemical Electric Light Company, Limited.—An agreement, dated 20th ult., and filed on the 27th ult., made between Leon Napoleon Loeb, of Church Alley, Basinghall St., and Mark Jacobs, of 11, Clarendon Street, Warwick Square, relates to the purchase of the patent rights of the former by the company for 3,000 fully paid shares of £1 each. The vendor is not at liberty to dispose of more than 1,000 of these shares during a period of 12 months from the date of allotment, and in any one year after the expiration of such period he may not (except by will or codicil) dispose of more than 200 of such shares. Registered Office, 19, Soho Square.

Electric Portable Battery and Gas Igniting Company, Limited.—The annual return of this company, made up to the 2nd ult., was registered 28th ult. The nominal capital is £100,000 in £5 shares. 16,706 shares have been taken up, and the full amount has been called thereon, the calls paid amounting to £83,515, and unpaid to £15.

Self-Winding and Synchronising Clock Company, Limited.—The registered office of this company is at 27 and 28, Leadenhall Buildings, Leadenhall Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

Consolidated Telephone Construction and Maintenance Company, Limited.

THE report of the directors of this company for the year ending March 31st, states :—Out of the balance of £5,208 18s. 4d. remaining to the credit of the revenue account to March 31st, 1885, a dividend of 2½ per cent. was paid to the shareholders in June; and £310 has been paid towards a settlement of the late directors' fees, which were in abeyance. The gross profits of the year amounted to £13,473 16s. 2d. After deducting the working expenses, £3,695 11s. 1d., together with £500 written off goodwill and patents, and £359 3s. at 10 per cent. depreciation of plant, machinery, and office furniture, there remains a balance of £8,919 2s. 1d. To this must be added £682 19s. 7d. balance from the year 1884-5, which makes a total of £9,602 1s. 8d. Out of this a dividend of 2½ per cent. was paid in November last, amounting to £4,215 18s. 9d.; and your directors now recommend that a further dividend of 2½ per cent. be paid, leaving a balance of £1,170 4s. 2d. to be carried forward to the next year's account. A compromise has been arrived at with certain of the late directors in connection with their fees. Sir Alexander Armstrong and Mr. Bigelow have voluntarily relinquished their claims, and the claims of Messrs Carnegy and Spensley have been settled for the total sum of £310. Colonel Gouraud, notwithstanding the circular sent round by him to the shareholders in July, 1884, stating that he voluntarily relinquished his fees, has commenced an action against your company for the sum of £1,426 15s., and your board have instructed the company's solicitors to defend the action. This leaves Sir Julius Vogel alone unaccounted for, but against this gentleman the company have a large claim in respect of the allotment of shares at the outset of the company's history.

London Platino-Brazilian Telegraph Company, Limited.

THE eighth ordinary general meeting of this company was held at the offices, Winchester House, Old Broad Street, on Monday, under the presidency of Mr. John Pender.

The secretary having read the notice convening the meeting,

The Chairman stated that they were suffering from the depression of trade, which was being felt severely at the present time in Uruguay; and they were also suffering through the Government of the Republic not being able to pay them. They were on perfectly good terms with the Government, and both the President and the Finance Minister had informed their manager how much they appreciated the service which had been rendered them by the company. In view of that meeting he had communicated with their manager, who had sent them a telegram in reply on May 14th, stating that a law had been sanctioned creating new bonds bearing 8 per cent. interest and 4 per cent. amortisation, that the debt of the Government to the company, $40,000, would be paid almost entirely with new stock at par, and that by the first mail he was remitting £500. He (the chairman) believed that the Government would continue to do their best to pay the company. A difference had arisen between the company and the Western and Brazilian company, as stated in the report for 1884, respecting this company's proportion of the receipts for telegrams sent since the reduction of tariff. The amount in dispute had been kept in suspense in the accounts. Another difficulty against which they had to contend had been the loss of traffic on account of the competition of the Brazilian Government land lines with the cables. Their receipts from the Western and Brazilian Company in the past year had been £8,614, as compared with £10,655 in 1884 and £12,638 compared with 1883. They, therefore, had not far to seek for the cause of the diminution in their dividend. As regarded the future, negotiations were pending. It was understood that the Chambers of Brazil had adopted a principle on which they would be prepared to make an offer to the companies interested in Brazilian telegraphs. The Western and Brazilian company was the first company to be treated with, as they had the larger interest, but no arrangement could be come to without the concurrence of this company. He concluded by moving the adoption of the report, and the declaration of a dividend of 1s. a share, making, with the interim dividend, a distribution at the rate of 1 per cent. per annum. Since the present board took office they had, he said, paid £52,600 in dividends, or an average of 2 per cent. per annum.

Mr. John Hollocombe seconded the motion, which was carried unanimously, and the retiring director and auditors were re-elected.

The West India and Panama Telegraph Company, Limited.

THE eighteenth ordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, on the 27th inst., under the presidency of Mr. C. W. Earle.

The Secretary (Mr. R. T. Brown) having read the notice convening the meeting,

The Chairman said they met under the somewhat depressing influence of declining traffics. In the present year, if the traffic receipts they had two years ago—in 1883—had continued what they were then, they would have been in a position, putting the same amount to the reserve fund, to pay a dividend of 5s. a share extra this year on the preference shares. The whole difference was occasioned by the depression of trade, which was particularly felt in the West Indies. The accounts were perfectly featureless as to expenditure, and they were very much on the same lines as they invariably were. The balance of £14,817 was practically the same as it was last year, although the revenue had fallen off; and the reason of its being the same was to be accounted for by their having had to bring the ships home to fetch out new cable, while the expense of the voyage was charged to cable account. In the present condition of affairs there was nothing for them to do but to maintain the cables, so as to be able to take advantage of any improvement in trade that might come about; and in connection with that consideration it was satisfactory to be able to report that the original Cuba-Jamaica cable which had been interrupted and inoperative for seven years had been repaired with a very much smaller expenditure of cable than anticipated. The interruption of this cable was in the northern half of the section, and in very deep water, and although they could get hold of the cable, so great was the depth that it was impossible to bring it up to the surface of the water. It was not in a condition to bear its own strain in lifting it to a very great height. The ship *Grappler* came home in order to take out the cargo of cable, 250 knots, and they then had an opportunity of discussing the question with the captain who had been engaged in these repairs. They left him a good deal of latitude as to what his operations should be, but sketched out what they thought would yield the greatest success, and the course that would yield the greatest success meant the saving of the greatest amount of the old cable. He went to where he found 1,300 fathoms of water, a good depth, and picked up the cable there, slipped in new cable of 46 knots, and ran to Santiago. There then remained about 25 knots to put in at the Jamaica end, and that was a total expenditure of 71 knots, whereas it was thought at one time that they would have to relay the whole of the cable. The cable was put through, and was working very satisfactorily. The other cable that had given so much difficulty—a cable very much in similar circumstances to the one just spoken about—the original Jamaica-Porto Rico cable, failed in November last. It had been for a long time interrupted, and it gave great difficulty; but in 2,400 fathoms of water the cable failed last November—not in the new cable put in, but in the original cable that had been lying there for fifteen years. It was impossible to get hold of the cable at that depth, and if they could get hold of it they could not get it up to the surface of the water, and must go to a considerable distance on either side of it until they could grapple it with success, and then join the two lengths of cable, and put it through again. The third cable—the Trinidad-Demerara section—had been again interrupted. It had been interrupted twelve times since 1879. It lay in shallow water; but there was something in the composition of the mud on that coast, poured from the rivers Essequibo and Orinoco, that has a deleterious effect on the iron wires of the cable. That cable had been there for 15 years, and it seemed to be going the way of all flesh. They had, therefore, made some proposals to the Government of British Guiana for replacing that cable with a new one of some improved construction to protect the iron wires from the effects of the mud in which the cable lay. They had not yet received any decision from the Government there, and it would not be advisable to discuss the proposals at present. But he hoped they would be able to lay a new cable there without very great sacrifice of revenue to the Company. The concluding part of the report was, perhaps, the most important. Of all the companies he ever knew there was none whose position so constantly fulfilled the idea of being between the devil and the deep sea as the West India and Panama Company. He had given instances of the disadvantages which the deep sea on the ground where they worked caused them. The other unpleasant neighbour assumed various forms. Sometimes it was a promoter with a wild scheme to connect islands where there was no traffic. On that matter they had had some revelations lately. However, it remained with the public whether these things were subscribed for. The promoters got a profit and left the public to fish for themselves, after they had made the cable, in very deep water and with very small traffic. He thought, after their experience in that part of the world, where there was very small business, and where the water was very inimical to the conditions of telegraphic working, it was not at all encouraging to subscriptions being got from the public. But the new enemy they had was their home Government. The history of this scheme, that was made the subject of an advertisement, as stated in the report, was as follows:—In the year 1882 there was a telegraph conference at Barbadoes. Representatives from the various West India colonies met there and decided that it would be expedient for them to have a direct line of communication to Halifax, Nova Scotia. They thought by doing that they would be able to get cheaper rates for their messages to England. He did not know how they expected that, because if the enterprise were conducted on commercial principles, there was no doubt that a cable all the way along the coast of America merely carrying the West India traffic, which was very small, would not be worked at so low a tariff as the land lines of America, which were supported by the traffic of the population through which those lines pass. They thought that it would be a nice thing to have a direct line, probably at the expense of the English Government. The matter was put before the Government, and the late Mr. Fawcett reported adversely upon it, and very fairly said that the West India and Panama Company would have very just cause of

complaint if the Government subsidised a new line. He was then Postmaster-General. The next time they heard of this was that the same scheme was advised by a Royal Commission that was sent out to investigate West Indian finances and West Indian affairs in 1884, and that Royal Commission advocated this scheme. The report of the Royal Commission came into their hands after their report was printed in 1884, and they appended a notice of what they said, and their objections to the scheme. They heard nothing more of it then, until this advertisement appeared last November. It seemed curious that the Government of the day, that was so much interested and so alarmed at the depression of trade and industry at the time, should with a light heart have advised a scheme by which about two millions of English capital were to be almost ruined, because he concluded that the Cuba Company would be very great sufferers as well as themselves if this line were established. It seemed curious that a Government which went out of its way rather in appointing a commission to inquire into that subject should at the same time have adopted a scheme that would so plainly depress a very large amount of capital, and also impair very much the power of this company to maintain the West Indian connections, which extended all down the Antilles. If their revenue was to be taken from them how was the company to keep up the connections with Demerara, Barbadoes, and other important colonies? They had laid their views and objections before the Government, and had heard nothing of the matter since. He hoped the subject might be allowed to drop. If such a scheme did come forward he hoped the public would be very careful how they subscribed to it. The water through which the cable would have to pass was deeper than any they had to deal with. It was referred to by the *Challenger* expedition as the deepest in the world. They could hardly get bottom with all their appliances for sounding. In making these remarks about this particular line, he was not saying anything about the expediency of a cable from Halifax to Bermuda, where there was no cable. Bermuda was a great naval station, and no doubt it was a praiseworthy thing for the Government to try and establish telegraphic communication with such an important spot as that. But as to Jamaica, there were three cables already there. No doubt the reason for proposing this step was the idea of having solely British connections with their naval stations and garrisons. But when we had such stations as Aden, Gibraltar, Malta, India itself, and our Australian colonies, all dependent to some extent on foreign communications, it seemed strange that they should go out of their way to deal with this matter in the manner he had referred to. It seemed rather strange to tell the English taxpayers to promote a line that would do so much damage to existing British capital. He then moved:—"That the directors' report and accounts to the 31st December, 1885, submitted to this meeting be, and the same are hereby received and adopted, and that, as recommended by the board, a dividend of 6s. a share on account of arrears of dividend on the first preference shares be, and the same is hereby declared."

Mr. Wm. Ford seconded the motion, and Mr. W. Griffith and Mr. William Abbott having spoken in support of the views expressed by the chairman in reference to the proposal of the Government, the resolution was carried unanimously.

Mr. Henry Holmes and Mr. Henry Weaver were re-elected directors, and the auditor, Mr. John George Griffiths, was also re-elected.

Mr. Abbot then proposed a vote of thanks to the chairman and directors for their services in the past half year. Mr. J. Newton seconded the motion, which was carried unanimously, the proceedings thereupon terminating.

West Coast of America Telegraph Company, Limited.

THE ninth ordinary general meeting of this company was held at the offices, 50, Old Broad Street, on Wednesday, Mr. Alfred Marshall presiding.

Mr. F. L. Robinson, the secretary, having read the notice convening the meeting,

The Chairman said the accounts showed a slight saving in the West Coast, and they hoped they might be able to maintain the expenses at a similar rate for the future. The *Retriever's* expenses were about £300 higher than in the previous year; sometimes the ship was docked at the end of the year, and sometimes at the beginning, and this would account for the variation in regard to that item. They had been very fortunate in not being called upon to make any extensive repairs; in this item alone there was a saving of £1,600, and they thought it prudent to take this into consideration in recommending the comparatively large sum for reserve. The gross earnings of the company, unfortunately, showed a falling off from previous years. This was almost entirely attributable to bad trade, a great part of which was produced by the war which had been going on between Chili and Peru, and which had impoverished the people of both those countries. They could only look for a very gradual improvement of this state of affairs. There was one item which called for explanation, the interest account. A sum of £381 was placed to credit, whereas it would seem that the investment of £10,000 of the reserve at 8 per cent. would produce a large sum. On the instructions of their auditors they had debited this account with loss of interest, incurred by cable transfers. They had up to this time adopted the plan of remitting money, instead of by bills, by cable transfers. This cost them the difference in the exchange, as the bankers charged a higher rate of exchange. They were taking measures to avoid this loss in future by resuming remittances by bills. The reports of their managers were very satisfactory as regarded the electrical condition and the thorough working order of the lines, and they were doing everything in their power to keep them in satisfactory order. Their staff, he believed, was quite exceptionally efficient. He moved in conclusion the reception and adoption of the report.

Mr. T. F. Campbell seconded the resolution.

The Chairman, replying to questions, said the receipts for the year showed no improvement. The traffic to May 31st had been £167,000 as against £208,000. During the last month, however, there seemed to have been some little sign of a reaction.

Mr. Taylor suggested that the *Retriever* was insured over her value, and said that she could be replaced for several thousands less now than was given for her in the first instance. This might cause some trouble.

The Chairman promised to consider the matter, after which the retiring directors, Messrs. A. Marshall and W. Roberts were re-elected, and the auditor, Mr. Weise, was also re-appointed, this bringing the meeting to a close.

Spiel's Patent Petroleum Engine Company, Limited.

THE first general meeting of this company was held on Monday at the offices, No. 1, Leadenhall Street. Mr. Heritage, who occupied the chair, referred to the fact that, although the company had only been in existence two months, the board had considered it wise to convene the statutory meeting. At the time the company was formed a special license was granted to Messrs. Shirlaw & Co., of Birmingham, who were to make the engines, the company also reserving power to manufacture. The board, however, considered it would be well to obtain the co-operation of Messrs. R. Hornsby & Sons, Limited, of Grantham, one of the largest engineering undertakings in the country. Both firms had now agreed to manufacture the engine under a royalty, and it was believed that the sale would be large. The board had also made arrangements for placing the manufacture of engines for South America in the hands of Messrs. Hornsby. This would be of great advantage to the company, but it had not been formed for supplying engines on the American Continent. The directors proposed that the company should acquire the patent rights for the continents of North and South America, reselling them to a subsidiary company to be formed on terms which would be very beneficial to the English company. This would be done without risk by the parent company, which would at the same time derive a substantial profit from the operation. A resolution to that effect was then adopted.

The Hammond Electric Light and Power Supply Company, Limited.—Mr. William Theobald, the liquidator of this company, has given notice that he is prepared to pay in full all admitted claims of creditors upon application at the office of Theobald Brothers and Miall, 23, St. Swithin's Lane, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 28th were £2,284, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May were £1,088 against £1,352 in the corresponding period of last year.

PROCEEDINGS OF SOCIETIES.

Royal Society, May 27th.

"Researches upon the Self-induction of an Electric Current." By Prof. D. E. HUGHES, F.R.S.

Numerous researches have been made upon the self-induction of coils of wire, and but few in relation to the influence exerted by the nature and geometrical sectional form of the electrical conductor when employed in straight wires as in those of a telegraph line with the earth as a return, or those of a single wide loop where the distance of the return wire is sufficient to prevent any appreciable effect from the *mutual induction* of separate portions of the wire upon each other; our present theories class all non-magnetic metals together, taking only into account their specific resistance and the diameter of the wires; they admit, however, a certain modification in magnetic metals due to their magnetic permeability, but we have had but little experimental evidence of the effect produced.

The whole subject seemed to me worthy of experimental investigation, and I have lately * given the results of a first series of experiments made last year. I have remarked since writing that paper many new and important effects, and I have made a new series of researches, the results of which I wish particularly to point out in this paper.

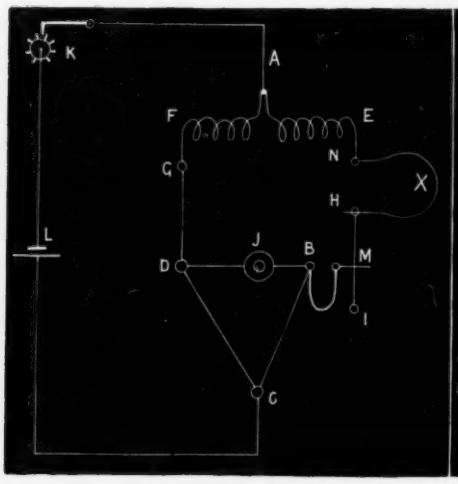
* "Self-induction of an Electric Current in Relation to the Nature and Form of its Conductor," *Journal of the Society of Telegraph Engineers and Electricians*, January 28th, 1886.

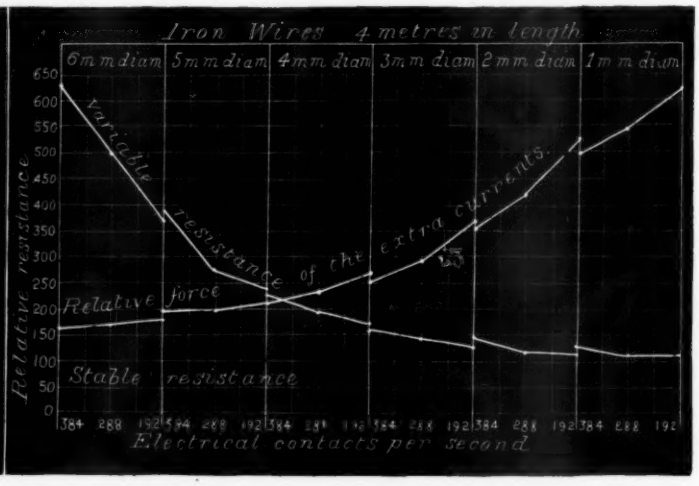
In my late researches I made use of a modified "Wheatstone's bridge" together with a portion of my "induction balance," by means of which the induced or extra currents from the wire under observation were balanced by a secondary current induced from an independent circuit; this gave excellent results, but the method has been criticised as having the fault of not being clear in its indications. In order to meet this objection and also verify the results which I had previously obtained, I constructed an entirely new bridge founded upon a most simple and well-known principle, and as the bridge admits of no change in the relative resistance of its sides, its action can be easily understood; it is with this instrument that I have made my new series of experiments.

The instrument consists of an ordinary Wheatstone's bridge, with the exception that a telephone replaces the galvanometer; there are in addition two coils of insulated copper wire, one in each portion of two sides of the bridge, by means of which the mutual self-induction of its convolutions can be increased or decreased as desired.

The electrical contacts are made either by a continuous periodic or tuning fork contact maker, or by a peculiar clockwork rheotome which I have made, in which a contact spring rests lightly on a wheel whose roughened surface is divided into eight equal parts of contact and insulation, by means of which we receive on the telephone eight equal periods of sound and silence each revolution of the wheel. We are by this means better enabled to appreciate feeble sounds than if they were continuous, and as the wheel can be made to revolve at any between two and 10 revolutions per second, we have from 16 to 80 periods of silence between each rubbing contact per second.

The following figure shows the theoretical plan of the electrical communications of the bridge:—





A, B, C, D are the four sides of the bridge, the telephone, J, replacing the ordinary galvanometer; the sides C, B and C, D are formed of German silver wire, each 50 cm. in length, 0·5 mm. in diameter, and 0·85 ohm resistance; the sides A, B and A, D have also 0·85 ohm resistance, so that the four sides have equal resistance, and this remains a constant during the whole series of experiments.

A, E and A, F is a continuous spiral of copper wire, formed of hard copper silk-covered wire of 1 mm. diameter and 4·80 metres in length, wound loosely on a boxwood cylinder of 3·50 cm. diameter and 30 cm. in length, on which it moves freely; the entire helix has 40 turns of 4 cm. diameter, each spiral being separated 5 cm. from each other; the spiral, however, is separated into two equal portions by giving a greater separation at the centre in order to allow it to be attached to a sliding collar of wood, by means of which we can press the spiral closer together on either side as desired; at E and F there are also adjustable collars of wood, and as the boxwood cylinder is graduated, we may (if the central collar is fixed) approach more or less either side of the helix, and read the degree of approximation of the coil, thus adjusting the mutual induction of each side to a perfect balance or zero. In practice I prefer moving the central collar, using the end collars only for the perfect adjustment of its zero, as we then have a double effect, viz., closing the coil say from A to F, increasing its mutual self-induction, and at the same time decreasing the previously balanced induction of the coil A, E, this not only gives a wider range of effect, but renders the scale readings more uniform; the end, F, of the helix is joined to about 10 cm. of German silver wire, completing the circuit from G to D; this supplementary German silver wire is simply for the purpose of making the resistance of A, D equal to D, C, and its length should be adjusted to this purpose; the end of the helix, E, joins directly with the terminal N; the wire to be tested, X, is joined to N and H; from H to I there is a second supplementary German silver wire allowing us by means of the contact side, M, which is in direct communication with B, to introduce more or less of the German silver wire in the side A, B. The resistance of the wire to be tested should always be less than that of the opposite side of the bridge, and we then make up the total resistance of A, B by sliding the contact slide, M, until the resistance of A, B equals A, D.

It will be evident that in the whole series of experiments there can be no change in the resistance of either side whenever zero is found, the induction coils or balance having the same proportional current in all the changes of the wires under observation, the battery and telephone circuit present also a continuous absolute relation; we may, however, when desirable, keep the resistance from H to M a constant, and vary the resistance or the length of the German silver wire, G, D, we then balance the wire, X, by an equal resistance on the opposite side of the bridge, but then the battery and telephone circuits no longer possess the invariable relations which are so extremely necessary in experiments of the nature of which I have been making.

The battery circuit is joined in the usual manner to A, C, the current can be interrupted by the rheotome, K, or by means of a commutator (not shown in the diagram) close the battery circuit, and transfer the contact maker to the telephone circuit, B, D; this allows us to observe the effect of an intermittent current compared with that of a constant or steady flow. M. Gaugain has termed the period of a steady flow of current the *stable period*, and that in which a rise or fall of the current takes place the *variable period*; these terms have since been generally adopted by telegraph electricians, and in order to avoid introducing new terms, they will be used in this paper.

It would require too much space to enter into the details of the construction of the bridge; special care is required in the construction of the balancing induction coils, and in securing perfect electrical contacts in all parts of the bridge; the induction balance requires calibration, and for this purpose I introduce as the wire, X, successive lengths of 10 cm. 1 mm. diameter copper wire, thus forming a table of values throughout the range of the induction balance, or by equal increments of 10 cm. of copper wire up to 20 metres.

Having no unit of self-induction to which my results could be quickly and practically referred, I have adopted as unit the self-induction of a straight copper wire 1 mm. diameter and 1 metre in length; this gives on my calibrated induction scale 100 degrees, and it is to this standard that all the comparative force of extra currents mentioned in this paper is compared.

The self-induction of a wire is proportional to its length, consequently a source of error might exist in the different lengths of the supplementary resistance wire, H, I, introduced to balance the resistance of G, D, but as we are enabled by the high specific resistance of German silver wire to obtain a very great change in resistance by a comparatively small movement of the sliding scale, this error in most cases of comparative experiments is but a fraction of 1 per cent., and when taken into account as it should be the error no longer exists.

The telephone used should be of the most perfect kind, and adjusted expressly for rapid and feeble sounds. I have found it best to employ an extremely soft Swedish iron diaphragm, without varnish or anything that can diminish or deaden the sound; its fundamental note should be higher than those generally in use, or at least 500 double vibrations per second, for we have to deal with extremely rapid effects which on short wires cannot be rendered evident upon a galvanometer, but which with a telephone in perfect adjustment are heard most distinctly with an electromotive force (?) in the battery circuit ranging from 0·001 to 0·250 ampère.

In the sketch of the communications the wire to be tested, X, is shown in the form of a wide loop, but in practice the instrument is constructed on two separate frames of wood articulated together at D, by means of which we can separate the terminals, N, H, and introduce straight wires, sheets, or tubes of lengths varying from 5 cm. to 1 metre.

The object of my researches being to observe the self-induction which takes place in straight wires, or in those of a single wide loop where the reaction from any return wire is at such a distance that its influence is not appreciable, I shall, therefore, use the term self-induction to indicate the effects due to the electric current in its own portion of the wire, and mutual induction to indicate those where the reactions of different portions of the current and circuit react on each other, as in the case of coils; and although some theoreticians consider the two cases as the same, they are, as my experiments prove, entirely distinct, for we have, as will be shown, for copper wires a low coefficient of self-induction with a high mutual induction, whilst in iron wires the reverse is the case, for we there have a high coefficient of self-induction with an extremely feeble coefficient of mutual induction.

Influence of the Nature of the Conductor upon its Self-induction.

I found, as shown in my late paper, that there was a marked difference in the specific inductive capacity of iron and copper, and this entirely agrees with well-known theories; but I suspected that there might be some difference in the non-magnetic metals independent of their specific resistance. For this purpose I made a series of experiments with wires of the same length and diameter, but of different resistance. These showed a marked difference provided the current was increased in proportion to its diameter or conductivity, but no difference could be found when the current was kept a constant, and the interior differences in resistance of the wires were compensated by an external added resistance; but if we take wires of different metals—all of the same length and resistance, but of different diameters—there is a marked difference due to the mutual reactions of the current in its own wire, being less in wire of large diameter than in small wires. These effects have been fully explained in my late paper, and have since been completely verified by the method used at present. I showed by the use of my late method a critical point in the rise and fall of the induced currents; this is not shown by the present method of compensating by external resistance, but the rapid decrease in the electromotive force of the induced currents, as indicated by the induction balance, is well shown by the present method. The following table shows the observed force of the extra currents for wires of the same length (1 metre), but of different diameters:—

	mm. 0·25	mm. 0·50	mm. 1·00	mm. 2·00	mm. 3·00	mm. 4·00	mm. 5·00	mm. 6·00	mm. 7·00	mm. 8·00	mm. 9·00	mm. 10·00
Iron ...	760	621	530	360	269	220	190	171	152	138	128	124
Copper	129	113	100	89	82	78	75	73	72	71·5	71·2	71

The fall in force is now even more rapid than shown by my late method, and it will be seen that iron is peculiarly sensitive to an increase in diameter, having nearly six times the force of copper in wires of 0·25 mm., and not twice the force of copper in wires of 10 mm. section.

Reactions of an Electric Current in its own Portion of Conductor.

The phenomenon of a constant decrease in the electromotive force of self-induction, as measured by the induction balance, with each increase of the sectional area of the conductor, is well shown by the present method, and an experimental investigation of its cause has shown that we should not consider a current in a wire as a single element reacting solely upon exterior wires, but that the current acts precisely similar as would an infinite number of independent streamlets of current reacting upon each other in the interior of its own wire similar to their known effects upon exterior wires. My experiments demonstrate this to a degree that leaves no doubt on my mind as to its truth, for according to this view we should be able to reduce the self-induction to a very great extent by employing thin flat sheets where the outlying portions are at a comparatively great distance from the central portions. This I have experimentally proved to be the fact, but this experiment alone does not show if the reduction of self-induction is due to a different arrangement of the current in sheets as compared with solids. If the reduction is due to the greater separation of the streamlets, then we should be able to reduce this induction in a still greater degree by employing a conductor composed of numerous small copper wires through which the current is equally divided, and which could be separated or brought close together as desired. This proves to be also an experimental fact, for the conductor formed of numerous strands has far less self-induction than a thin sheet when its wires are separated, so that they can no longer react on each other, and surpasses the thin sheet and approaches the value of a circular wire when these wires are brought near together, so that their mutual reactions can approximate those of the numerous streamlets in a solid conductor.

Iron shows a still greater reduction in its self-induction when in the form of thin flat sheets or numerous small iron wires separated from each other, with the exception that we cannot restore or approach the value of a solid wire by bringing them in close proximity. The reduction of the induced currents by employing thin sheets instead of a wire is so great in iron that we could not account for it on the mere separation of contiguous portions of the same current, but if we assume that the comparatively high force in iron wires is due to the induced circular magnetism, and that this almost disappears in flat sheets, we account for the fact that a thin flat sheet of iron has less inductive capacity than a similar sheet of copper of the same resistance, but of different widths; and if thin strips of copper, brass, lead, and German silver are compared with similar iron strips, and their resistance rendered equal by the added resistance in the bridge, no difference is found between iron and the non-magnetic metals, for under these conditions their inductive capacities appear equal.

Reactions of an Electric Current between Separate Portions of the same Conductor.

In order to distinguish two distinct effects I have defined self-induction as the effect produced by an electric current on its own portion of the wire, and mutual induction as the effect of the reactions between separate portions of the wire on each other.

The mutual induction in iron and copper wires is very different in degree, as shown by the following table:—

TABLE I.

Wires, silk-covered, 1 m. in length, 1 mm. in diameter.	Comparative force of the extra currents.	Strips or ribbons, silk-covered, 1 m. in length, 10 cm. wide, 0·1 mm. thick.	Comparative force of the extra currents.
Copper wire, in a single close loop where each side is in close proximity	18	Copper strip, in a single close loop where each side is in close proximity...	14
Copper wire, in a single wide circular loop	100	Copper strip, in a single wide circular loop	60
Copper wire, in a coil of 3 cm. diam., having ten layers in close proximity ...	607	Copper strip, in a coil of 3 cm. diam. having ten layers in close proximity ...	580
Iron wire (soft) in a single close loop, as above...	440	Iron strip (soft) in a single close loop, as above	16
Iron wire, in a single circular wide loop ...	502	Iron strip. in a single circular wide loop...	60
Iron wire, in a coil as in the case of copper	570	Iron strip, in a coil as stated for copper ...	578

There is a remarkable fall in the induction of a straight wire or single wide loop of a copper wire when this wire is doubled upon itself as a return wire in close proximity. The effect of mutual induction is also shown by the equally remarkably rise when the mutual induction of ten layers of a coil react on each other. This is well known, but what I believe has not yet been experimentally observed is the remarkably feeble mutual induction of iron wires, either when in parallel return in close proximity or when in coils of numerous layers. The percentage of increase of induction in a copper wire from a wide single loop to that of the ten layers being 507 per cent., whilst in iron under precisely the same conditions there was an increase of but 13·6 per cent.

That this remarkable difference as shown between the mutual induction of iron and copper wires is due entirely to the circular magnetism in the iron wire, and that the mutual reactions of the streamlets of the current in a thin flat iron conductor prevent this formation I have proved in various ways, for if the circular magnetism is the cause, flat iron sheets which have as low self-induction as copper should be equally sensitive to mutual induction as the non-magnetic metals, for they no longer in any appreciable degree possess the protecting magnetic sheath which enfeebles the mutual reactions of iron wires upon each other; this proves to be the case, a thin ribbon of iron having the same coefficient of mutual induction as copper, and it no longer behaves as a magnetic body.

Table I. shows the difference in the mutual induction of iron wires and strips; it will be seen that when the iron is in the form of a wire the circular magnetism produces a marked difference between iron and copper, whilst in the form of flat strips the iron resembles copper (as regards mutual induction) in every respect.

Influence of Circular Magnetism.

I have shown in my late paper that an iron conductor composed of numerous fine stranded wires (as in a rope) behaves like copper, and this I regard as entirely due to the breaking up or prevention of circular magnetism; I also showed a phenomenon which I could not then explain, viz., that when an iron wire was heated to a yellow-red heat it lost its previous high specific inductive capacity and behaved like copper. The effect of heat upon magnetism is well known, consequently we can readily explain the fall in its inductive capacity by the disappearance of its circular magnetism. I found also that in thin flat strips of iron there was no change whatever in its inductive capacity at the yellow-red heat; this can now be readily explained: it behaved like copper when cold, and, having but little circular magnetism to destroy, there was no appreciable change produced, except that due to the extra resistance caused by the increased temperature of the strip, and to which copper and iron are almost equally sensitive, consequently we may consider iron (when in the form of thin flat sheets) to behave like non-magnetic metals throughout all temperatures.

Influence of Self-induction on the Resistance of the Conductor.

A phenomenon of great importance is the effect which I have observed of the resistance of a wire being greater during the rise of the current, as in the variable period, than that measured or known during the constant flow, as in the stable period; by resistance I mean a pure ohmic resistance, a resistance which can only be measured, expressed, or balanced in ohms, and, whatever the cause, the effect is one of pure ohmic resistance.

We can imagine that at the first moment of contact there is no current flowing through the wire, its resistance is then infinite, but the current gradually increases in force until it arrives at its maximum, as in the stable period. We have thus between the moment of contact and period of steady flow a variable period wherein the resistance falls in the form of a curve from infinity to its well-known stable resistance; the telephone is unable to give the exact form of this curve directly, but it gives by the nul method comparative results as to the different duration in time of the curve in different metals.

If we take a straight copper wire 1 metre in length and balance its resistance in the stable period, we shall find that there are only traces of a difference in its resistance in the variable period, and we can balance its self-induction by the induction balance; but if we replace the copper by an iron wire of the same length, or even a much shorter wire, viz., 20 cm., we find that in the variable period we can no longer balance the wire by the induction balance alone, but we must compensate for its increased resistance by the sliding scale, the amount of subtracted German silver wire expressing in fractions of ohms (the value of the wire being already known) the additional resistance of the iron wire in the variable period; we can thus reduce or balance the iron wire to a perfect zero, provided the current from the battery does not exceed 0·10 ampère; but with greater current there will still remain a slight muffled sound, which cannot be reduced to zero either by the induction balance or the resistance slide. It therefore became important to determine if this muffled sound was due to a difference in resistance which could not be balanced, or to the lengthened duration of the extra currents being slower than the balancing current from the induction balance; the latter proved to be the case, for on prolonging the duration of the balancing currents from the induction bridge by introducing a core of iron in its coil, the balance or zero became absolutely perfect. In this case we must choose between cores of different diameter to find one whose reaction on the time effect of the induction coil equals the retardation of the extra currents in the wire tested.

If we observe the method employed in the bridge, we shall see that the induction balance can balance the extra current of the wire, X, irrespective of the position of the resistance slide, M, or any relation between the sides A, B and A, D, but we cannot equalise the resistance of these sides except by the necessary adjustment of the resistance slide, consequently when we are forced to adjust the induction balance we are compensating the extra current, and when we are forced to move the resistance slide we are balancing resistance.

The disturbance in the bridge caused by the change of resistance of the wire tested in the variable period, causes a momentary primary current to pass through the telephone in the same direction as the extra current, and if these are not separated by balancing the extra current by an induction balance, the mixed effect would be read as a single effect of the extra current. To show the importance of separating these two effects, it is only necessary to say that in most of the cases cited in this paper the momentary primary current due to the extra resistance greatly exceeds that of the extra current; consequently all measurements taken wherein this separation is not complete, gives the result of a mixed effect.

(To be continued.)

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, May 27th, Professor HUGHES, F.R.S., President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, it was stated that Mr. Leonard Wray had presented to the society a number of botanical specimens of gutta percha plants obtained from Perak. A paper was then read by Captain P. CARDEW, R.E., member, on "The Telephone as a Receiving Instrument in Military Telegraphy."

I have been asked to give you a short account of the system of telegraphy with vibration currents, using the telephone as a receiving instument, which was invented by me five years ago, and has since been used with considerable success in several campaigns.

Shortly after we became possessed at Chatham of any really well-made telephones, the idea of using them as receiving instruments, for telegraph messages sent by the ordinary Morse code, struck Major Armstrong, who was then in charge of the Electrical School, as probably applicable to field telegraphy, where interference from induction from parallel wires was not to be apprehended, and where the extreme sensitiveness of the instrument would probably enable work to be carried on in spite of faults of insulation, hasty joints, bad earth connections, &c.

This idea was worked at for some time. It was found that there was some difficulty in reading, due to the almost perfect similarity of the make and break clicks in the telephone and the consequent liability to read the signals reversed. Still, this was probably to be overcome by practice, and eventually it was determined to try through what length of bare wire laid on the ground without any insulation the method would admit of carrying on work.

Some experiments had also been carried out at this time with some vibrating sounders* sent for trial by Messrs. Theiler.

These are on the same principle as an ordinary chattering bell, but arranged to give a musical note.

They were intended to be used as ordinary sounders, but the difficulty was, that they interfered with each other if more than two were used on one circuit.

The following is an extract from a report I made to the Royal Engineer Committee on the experiments carried out with this bare wire:—

"Report of an equipment with 15 miles of bare wire laid on the ground, with a view to ascertain the possibility of signalling through it by means of telephones.

"Telegraph School,

"School of Military Engineering, April, 1881.

"The wire consisted of 10 miles of No. 16 B.W.G. soft iron galvanised wire, and 5 miles of No. 16 B.W.G. copper wire. This arrangement possessed the disadvantage of keeping a continuous current on the line from the earth contact of the two wires, and of tending to destroy the iron wire, but, as the line was only required for a short time, this was not material.

"Permission was obtained from the authorities of the London, Chatham, and Dover Railway, to lay the wire at the side of their line of rails. It was consequently laid in a loop extending from a short distance on the up side of the New Brompton Station to within a short distance of Newington Station, and back again on the other side of the line.

"To ensure the wire being well out of the way of the traffic, it was laid in the *hedges* in many places. In other places it was laid on the ground, even picketed down under stiles so as to prevent its tripping people up. The ground was generally newly made or garden ground, and the soil of fair conductivity. Rather more than half the wire was thus laid in the hedges.

"At road crossings the wire was stretched over a pole at each side.

"For convenience, one end of the wire was brought into the R.E. Institute.

"This necessitated using poles to avoid interference with traffic, and for convenience some poles carrying existing lines were made use of. This introduced induction signals, so that, in getting signals through, the following difficulties had to be contended with, viz.:—

"1. Very bad insulation.

"2. Continuous current from the different metals in the line wires and earths employed.

"3. Induction currents confusing signals.

"The line resistance was never accurately obtained, this being impossible under the conditions, but it must have been about 900 ohms, while the insulation test from the institute gave on several days a resistance as low as 300 ohms, which of course included part of the line resistance, the position of the resultant fault being at any rate some distance beyond the end of the insulated wire, so that the true insulation resistance must have been extremely low.

"The first intention was to use the telephones as Morse instruments with an ordinary key as before proposed, the connection being as shown in fig. 1.

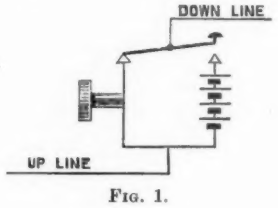


FIG. 1.

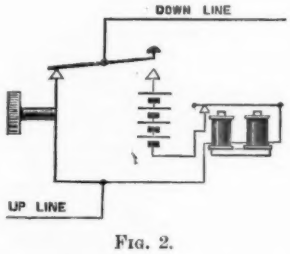


FIG. 2.

"This was tried with batteries of 10 Leclanché cells at each end. At the institute, in a quiet room, there was no difficulty in reading these signals, but the ear had to be kept quite close to the instrument. At the other end there was some difficulty in reading signals when first tried, owing to a very high wind producing noises in the telephone. To get over this I tried the effect

* See ELECTRICAL REVIEW, February 15th, 1879.

of putting on a Theiler Sounder, as in fig. 2, thus sending a vibratory current out to line."

"This was completely successful, the note produced being very easily read and quite distinct from the induction signals, and the noises due to earth currents.

"Signalling was carried on for several days by this method, without any difficulty, clearly demonstrating that by this means signalling can be kept up through bare wire laid on the ground (as rapidly as cable), and afterwards poled and insulated when circumstances permit.

"Another advantage of this use of the telephone is, that no adjustment of the receiving instrument is ever necessary, thus eliminating a fruitful source of delay.

"For ordinary insulated lines the battery power required is very small, and the telephones are ready when necessary to be used in the ordinary way, and would no doubt be found very useful by the general and his staff as a means of personally communicating orders."

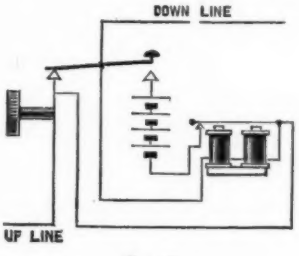


FIG. 3.

"Another method of connecting the Theiler Sounder is shown in fig. 3. This I think preferable to fig. 2 in general, for the following reasons:—

"1. The current through the Theiler sounder is practically uninfluenced by any change occurring in the line resistance.

"2. In the case of a dirty back contact in the key (a fault of frequent occurrence causing much delay), continuity will still be established through the coils of the Theiler sounder.

"3. Fewer cells can be employed (four cells Leclanché being quite sufficient for ordinary circuits).

"The note given by the Theiler sounder in the telephone is quite as loud as the tone of the ordinary sounder under ordinary circumstances. When working through bare wire laid on the ground it is of course low, but still quite distinct if held close to the ear.

"A simple apparatus for holding the telephone in the required position, so as to leave the arms free, could be easily designed. Two telephones, one to each ear, might then be advantageously employed.

"From the results of this experiment with bare wire, I feel confident in recommending the employment of this combination of Theiler sounder and telephone in place of the ordinary sounder for field service, over which it possesses the following advantages:—

"1. The possibility, as demonstrated, of working through a considerable length of bare wire.

"2. The receiving instrument requiring no adjustment for altered conditions of line and different stations, &c.

"3. The reduction of the battery power required to be carried to at most one-fourth of the present requirements.

"4. The continuity of the line being ensured, independently of the back contact of the key.

"5. The power of working through very bad earths, saving much time in very dry places.

"6. That the note signals are more easily read than the interval signals by men untrained to either."

Experiments were immediately afterwards carried out by the field telegraph troop at Aldershot with this system, which was reported on very favourably by Colonel (then Major) Hamilton, R.E., commanding the troop, from whose report I need only extract the following paragraph:—

"I should add to the above, that the experiment was tried of poling the line which had been laid on the ground while messages were being sent through the line, and the poling did not in the least interfere with the reading of the messages. It therefore follows that a line of bare wire may be laid as fast as an army advances, and that a party may follow slowly and pole the line; the communication being established from the first laying out of the line."

An extensive trial of the system was in consequence approved. Rather unfortunately, in order to save expense, it was proposed to convert the existing old pattern field sounders into Theiler or vibrating sounders. These instruments were mostly in a shaky condition, and in consequence were liable to get out of adjustment when used as vibrators, for which purpose it is essential that all parts of the instrument, except the vibrating tongue, should be very firmly fixed.

Some of these converted instruments and telephones were taken out to the first Egyptian expedition, in 1882; and this system was used exclusively in sending the messages from the field of Tel-el-Kebir from 8·30 a.m. to 6 p.m.—115 messages, averaging 30 words each, being recorded as having been sent during this time, while some messages were unrecorded.

A new pattern of vibrator was, however, then considered essential. As the noise made by the vibrator and the telephone at the sending end was sometimes a nuisance, it was reduced to a minimum in this instrument by using a very light armature—simply a piece of ferrotype or tinned iron—and by means of this small key at the side of the signalling key which, when depressed by one finger, short-circuited the telephone.

It was considered desirable to practically determine, if possible, the limit of distance to which the system was workable on a long aerial line isolated from other wires. As this could not be obtained in England, the Indian Government was asked to try the experiment, and the following is an extract from the report of the electrician of the Government Telegraph Department:—

"Weather clear and fine.

"Worked Tuticorin, a distance of 375 miles, by wire from Calicut, with 30 Minotti cells, reducing battery subsequently to four cells. Signals from Tuticorin very clear, and could, with the stronger current, be read on telephone held at some distance from the ear; but with the weaker current it was necessary to hold the telephone pressed against the ear.

"The thick, or No. 1 armature, was used at both ends throughout.

"The two parallel wires to Beypore (9 miles), and Malapuram (18 miles), also line to Vayitri and Tellicherry, were working at the same time, and all together during the above experiments, the two latter being suspended on same posts as the others, for a distance of ten yards from the office only.

"The beats from the offices working as usual were distinctly audible in the telephone, but, except when the weaker battery of four cells was on, the signals from Tuticorin on the vibrator were not interfered with—the musical not riding above the induction beats. Following day, weather cloudy and some rain.

"Worked Tuticorin at 7 hours, beginning with 10 cells and decreasing to two cells. The lines were disconnected at Cochin, 125 miles from Calicut, and the ends of the wires thrown down and, lying on wetted floor of signal room, worked well with 4 cells."

This clearly shows that, with an insulated aerial line, very great distances could be worked by this system without translation.

In 1883, some experiments on General Post Office wires were made with this system, of which the following is a condensed report:—

"1*st Experiment*.—New Cross to Chatham (30 miles), worked easily with one cell, and very good signals with 6 cells; also worked through wet string and human bodies.

"2*nd Experiment*.—New Cross to Bristol 123 miles on poles and eight underground. Chatham to Bristol, 158 on poles and ten underground—wires on the same poles—could hardly get through with 60 cells.

"Ordinary apparatus worked with 30 cells.

"The vibration currents were destroyed by induction, especially in the underground part through London.

"3*rd Experiment*.—Two parallel wires between New Cross and Dover, with vibrators. New Cross could read messages sent on both circuits simultaneously. Dover was not so successful, chiefly because the operators were not accustomed to read by sound. Signals audible with two cells and good with 5—67 miles open and two miles covered.

"4*th Experiment*.—Two parallel wires between New Cross and Chatham, fitted with ordinary ink-writers, also between the two vibrators and condensers."

This was an idea of mine to get an independent vibration circuit superposed on ordinary working, and was quite successful—all three circuits working quite independently. Signals audible with two and good with 10 cells on vibrators—30 on the Morse.

In place of the condensers an ordinary plate lightning protector was fitted, and afterwards a resistance of 10,000 ohms, without interrupting the working.

"5*th Experiment*.—New Cross to Chatham. To each end of one of the wires, between New Cross and Chatham, both vibrators and Morse recorders were connected, the vibrators being separated from the line wire by the plates of condensers.

"When Chatham sent simultaneously on both his instruments (separate messages, of course), New Cross could read on both his; but when Chatham sent on his vibrator at the same time as New Cross sent on his Morse instrument, the signals could not be read but became mixed up and confused.

"6*th Experiment*.—Two wires known as 197 and 198 were tapped at Bristol station and Paddington (118 miles apart); these wires were not cut or terminated, they were carrying powerful currents from the General Post Office to stations in the West of England and South Wales.

"Between them, as in experiment 4, were placed vibrators and telephones.

"The experiment was a failure, as, owing to the strength of the working currents, the signals in the telephones were completely overwhelmed by the noise of the induced currents. Occasionally, at intervals, the signals sent from Paddington were audible for a moment.

"7*th Experiment*.—One wire, 193, running parallel to the above, was cut at Bristol and Paddington, and vibrators and telephones fixed upon it. Communication was carried on, in spite of the induction from the neighbouring wires.

"8*th Experiment*.—A cable containing seven wires runs between Dublin and Holyhead, about 65 miles. Six of these carry the ordinary postal telegraph business, the seventh is 'dead,' *i.e.*, has become so earthy that none of the ordinary telegraph instru-

ments will work it. Vibrators and telephones were accordingly placed in connection with this dead wire; owing to the induced current from the other wires communication could not be carried on until the working upon them had been temporarily suspended. As soon as these currents ceased, however, messages were successfully exchanged over the 'dead' wire by the vibrators.

"*9th Experiment.*—A bare G.I. wire was laid alongside of the railway on the ground, from Chatham to Faversham, about 16 miles—it was in contact with the railway signal wires and with stay wires, and piles of sleepers and of railway iron, which had been deposited upon it—vibrators were, as before, joined to it: at first no satisfactory results were obtained; the wire was cleared from contact with the signal wire and some of the stays, and afterwards communication was successfully established, interrupted sometimes by the noise of passing trains."*

In commenting on these experiments, on October 1st, 1883, I remarked: "It is worth consideration, whether the system of working tried successfully in experiment 4 could not be usefully adopted in the postal telegraphs. . . . . The method is much improved by the addition of magnets on the Morse circuit, as the Morse clicks can be practically softened off in the telephone to such an extent, by being passed through the coils of a magnet, as to avoid all interference with the vibration signals."

Immediately after this I tried the effect of working as in experiment 5, but with the addition of an electro-magnetic coil of considerable inductive power, on each end of the line, between the Morse instruments and the vibrators, and found it work perfectly.

This method was soon afterwards tried between New Cross and Chatham, and worked perfectly, although the condition of the line was so bad and variable that we could not succeed in duplexing the Morse. By this method, therefore, two independent circuits can be at once established on a single wire with single instruments, without any balancing or nice adjustments.

Of course it is evident that the system is practically the same as Van Rysselberghe's, but it was brought out quite independently, and in the manner detailed; and the fact that he can successfully employ it with the weak speaking currents shows how certainly it must work with the far more powerful vibration currents.

Although the separators were not tried either in Bechuanaland or Egypt, the vibration system was found very useful, notably in one case in Egypt, where working was carried on for six weeks through a bare wire laid on the ground for a distance of 23¼ miles, from Kaibar to Abu Fatmeh, and absolutely buried for a distance of 200 yards through the camp at Kaibar. This distance is rather longer than that worked through in England, viz., from Chatham to Faversham; but it was not really so severe a case, as the ground in the Soudan was decidedly dry, and that in England distinctly wet. The most noteworthy feature of this trial is that only two small Leclanché cells were used at either end, and that with this small battery-power, through a line making dead earth all the way, the call signal was audible, even without holding the telephone to the ear.

The vibration system is now applied by us in many ways. For instance, with ordinary telephones a buzzing armature is fixed to the induction coil, causing a vibratory current in the primary circuit, which is reproduced as a call signal in the telephone, thus dispensing with the ordinary bell. The note is loud enough to be heard in an adjoining room.

I have also adapted it to an instrument for testing lightning conductors.

The instrument was got out before the publication of our President's most valuable researches in the field of self-induction, and I do not see my way to obtaining anything better than a minimum of note when arranged for balancing very low resistances. A sonometer has since been added to it, the effect of which I have not yet tried, but which I expect will overcome the difficulty.

We are not yet quite satisfied with our pattern of vibrating transmitter, and Messrs. Theiler, who unconsciously produced the first one, have recently brought out an improved pattern, which, with some modifications, will probably be adopted.

It is worked on a primary low resistance coil, and the secondary coil throws an alternating induced current on line.

I had never taken to this obvious modification, except as a call signal for telephones, as the simpler form enabled increased battery-power to be more effectually used, but the power of the purely induced current in the telephone is certainly marvellous, and this pattern, with three cells, has given as loud a note as our present pattern with ten cells, under all conditions of artificial line.

The last instrument I submit to-night is a "Combination Box," adapted for speaking or telegraphing.

The vibrating transmitter is double wound and acts as an induction coil for the transmission of speech. The microphone transmitter used is a "Hunnings" or "Moseley," arranged with a handle which forms a switch. This solution of the switch difficulty, which gave us some trouble, is due to Quartermaster Sergeant Kenney, R.E., and is certainly the most efficient we have yet tried. It performs two offices: when speaking, it is squeezed in the hand and completes the circuit through the microphone and primary coil; when listening the pressure is relaxed, the battery circuit is broken, and the secondary coil short-circuited. Thus the battery circuit is never kept on longer than is absolutely necessary, a most important point in the field, where small patterns of cells must be used and renewals may not be at hand.

In the discussion which followed the reading of the paper,

Major BERESFORD, R.E., said that he considered that Captain Cardew was working in the right direction as regards field telegraphy. The question of outpost telegraphs is a most important one. The employment of Captain Cardew's method of working a telephone on an ordinary circuit was valuable, inasmuch as only one wire could be used for a field telegraph. The only objection to the Theiler sounder was that the buzzing sound was trying to the ears.

Mr. VON FISCHER TREUENFELD would ask as to the admissibility of a telegraphic apparatus for field purposes which left no record. Opinions on this point differed greatly. In the German army a recorder was considered to be an absolute essential, and General Von Chauvin in a work on Field Telegraphy had emphasised this. A more recent writer had gone so far as to ridicule the idea of a non-recording instrument. Personally he (Mr. Treuenfeld) was in favour of sounders and especially of buzzing sounders, as they can be worked through uninsulated wires and consequently enabled a line to be brought well to the front.

Dr. JACQUERS had noticed for years the inductive disturbances which took place on telephone wires and had made a practical use of the fact. Telegraph signals could be distinguished on telephone wires which were several miles distant from the telegraph wires. He had had specially erected two wires, each half-a-mile long and six miles distant from each other, and the signals on one could be distinctly heard on the other.

Mr. DONOVAN pointed out with reference to recorders *versus* non-recorders for field-telegraphs, that non-recorders were exclusively used during the American civil war.

Mr. PREECE said that he could endorse all that Captain Cardew had said. He was himself greatly interested in the experiments, since they involved the question of increased capacity for the wires. The objection to the buzzing sounder was, that inasmuch as the Wheatstone transmitters ran at a rate which gave 200 vibrations a second, the sounds from these might overpower or confuse the ordinary buzzer sounds and it would be impossible to superimpose telephone signals on these. The underground wire difficulty would also have to be considered. As regards the increase of working capacity which the Cardew system admitted of, it was somewhat curious that in cases where two wires were available to enable the system to be carried out, an increased capacity was not wanted. He would mention that the Delany multiplex system enabled the working capacity of two circuits to be increased to that of twelve. The vibrating call to which Captain Cardew had alluded had been adopted in the Postal Telephone exchanges to call up a subscriber who had left his call bell disconnected by not replacing the telephone tubes back on the switch hooks.

Captain CARDEW in replying said that Mr. Donovan's statement with regard to the use of non-recorders during the American civil war was an answer to Mr. Treuenfeld. The experience of the Egyptian campaigns, also, had not proved that a recorder was required. Experiments had been tried across the Solent with reference to telegraphing by induction on the principle of the experiments referred to by Dr. Jacquers.

A paper was then read by Captain H. R. SANKEY, R.E., member, on "A Problem relating to the Economical Electrolytic Deposition of Copper."

In the discussion which followed the reading of the paper,

Colonel STODDART, R.E., said that the first experiments tried at Chatham with dynamos in the place of Smee batteries for electroplating were not satisfactory, but subsequent improvements resulted in such success that the deposits obtained were far superior to those obtained from a battery. The whole of the details were worked out by Captain Sankey.

Mr. BERNSTEIN stated that in Germany there are more than six works in which more than a ton of copper is deposited per day by electric power. The copper obtained is of very high conductivity. As regards the cost of deposition, when the copper is required in quantities, it is cheapest to use a comparatively strong current, though this strong current cannot be increased indefinitely.

Prof. FORBES considered that the whole question could not be reduced to the mathematical perfection suggested by Captain Sankey, as the number of cases to be dealt with were very numerous indeed. From an examination made at Messrs. Lambert's works at Swansea, where copper was extracted from the ore, in order to leave the gold and silver, he had come to the conclusion that most economical and satisfactory results were obtained with one tank, and a very low electromotive force, as the plates can be taken out just as required without interference with the rest of the circuit. The proper dynamo to use is one to give enormous quantity with very low electromotive force. He stated with confidence that in the future copper kettles and pans would be manufactured by electro deposition at a cost of only a few pence per pound, instead of, as at present, at a total cost of eighteen pence. The coppering of ships' bottoms would also, he believed, be effected by electro deposition.

Captain SANKEY, in reply, stated that his intention was not to give a general solution of the whole problem, but to assist only to that solution. As regards the single tanks being cheaper than a series, the factors in the mathematical investigation prove this to be the case, but the leads bring up the expense.

* Attempts were made to work along the bare wire with the ordinary Post Office relay. Signals could not be obtained further than about a mile.

At the termination of the discussion,

The PRESIDENT announced that it was proposed to hold the annual conversazione at Portsmouth, and by the kind permission of the Admiralty the dockyard, &c., would be viewed; the date would probably be about June 29th.

The meeting then adjourned.

Physical Society, May 22nd, 1886.

Professor BALFOUR STUART, President, in the Chair. Messrs. C. A. Bell, W. C. Johnson, and James Swinburne were elected members of the Society. The following communications were read :—

"On the sympathetic vibrations of Jets." By Mr. CHICHESTER A. BELL. It has been assumed hitherto that a gaseous or liquid jet vibrates under the influence of a limited range of tones only; effective tones being those which do not differ greatly in pitch from the normal or proper tone of the jet, discovered by Savart and Sondhauss. The author has found, however, that when the pressure under which a jet escapes is not too great, the latter is affected by all tones lower than the normal, as well as by some above it. Changes may be excited in a jet of either kind by vibratory motions of the jet orifice, or of the fluid behind, or external to the orifice. These changes take the form of slight swellings and contractions, which become more pronounced as the fluid travels away from the orifice, and finally cause the jet to break or become discontinuous at a distance which depends upon the intensity of the initial disturbances. At any point within the continuous portion of the jet the successive swellings and expansions represent both the form and the relative intensities of vibrations impressed upon the orifice; and the jet is, therefore, capable of reproducing very complex sounds, such as those of speech and music. A vibrating jet of air does not, however, emit sound when it plays into free air, or into the wide end of a tube communicating with the ear, but when it plays against a very *small* orifice in the end of a hearing tube, loud sounds may result. This reproduction is most intense when the hearing orifice is placed in the axis of the jet, just within the breaking point; but becomes gradually feebler as the hearing orifice is moved towards the jet orifice, or out of the line of its axis. Beyond the breaking point the sounds from the jet at first become confused, and finally are lost. A jet of gas, like a liquid jet, only vibrates so as to produce its normal tone when it strikes upon some obstacle which serves to diffuse the disturbances due to impact, or throw them back upon the orifice. The vibrations of an air jet are also loudly reproduced as sound, when it is directed against a small flame below the apex of the blue zone. Liquid jets are but slightly sensitive to aerial sound impulses, but become highly sensitive when the jet tube is rigidly attached to a sound board. The vibrations of a jet so mounted are best perceived as sound when the stream strikes upon a rubber membrane tied over the end of a narrow tube which communicates with the ear. For accurate reproduction of speech and sounds in general the jet should be at such a pressure as to respond visibly to a note of about 4,000 vibrations per second; and the membrane should be at such a distance from the orifice that the jet never breaks, and becomes discontinuous above its surface. The vibrations of very fine jets of any conducting liquid become clearly audible when a portion of the jet, or the "nappe" formed when it strikes upon a flat surface, is included in circuit with a battery and ear telephone. This may be accomplished by letting the jet impinge on the end of an ebonite rod, through the centre of which passes a platinum wire; the upper end of the rod is surrounded by a short tube or ring of platinum, the upper margin of which forms a continuous, slightly convex surface with the exposed end of the central wire and the ebonite. The wire and ring form the terminals of the circuit, which is completed through the "nappe." Distilled water containing $\frac{1}{300}$th of its volume of pure sulphuric acid is recommended as the jet liquid.

The author advances a new theory to account for the growth of the vibratory charges in liquid and gaseous jets.

"On some Thermodynamical Relations." Part V. By Professor W. RAMSAY and Dr. S. YOUNG. In parts I. and II. of this series of papers it was shown that the ratio of the absolute temperatures of any two bodies corresponding to a given vapour pressure bears a simple relation to the ratio at any other pressure, which may be expressed by the equation $R^1 = R + c\,(t^1 - t)$; where R^1 and R are the two ratios, c is a constant, and t^1 and t are the temperatures of one of the two bodies. The determination by Schumann (Pogg. Ann., N. F. 12, 46) of the vapours of methyl formate, and 27 homologous ethers, made it possible to compare the vapour pressures of a large number of bodies belonging to the same class. It was found that when the ethers were compared with ethyl acetate, which was taken as the standard, in every case $c = 0$, and therefore $R^1 = R$. The pressures corresponding with the three pressures, 200, 760, and 1,300 mm., are given by Schumann. Taking the mean value of R for those pressures as correct, and recalculating the temperatures, the greatest difference between the found and recalculated temperatures is 0·7° C. The vapour pressures of water or any one of the ethers being accurately known, it is sufficient to determine the boiling point of any ether belonging to this class, in order to construct its vapour pressure curve. The absolute temperatures corresponding to the pressures 200 and 1,300 m.m.x. for any ether are ·89795 t and 1·0488 t, where t is the boiling point at normal pressure in absolute temperature.

A Grid-iron slide Rule, by Mr. Stanley, designed by Mr. Thacker, was explained by Mr. C. V. BOYS. It was equivalent to a slide 60 feet long, and performed multiplication and division with an error not exceeding the $\frac{1}{20000}$th part.

Specimens of safety explosives, and their results in shattering blocks of lead, were exhibited by H. SPRENGEL.

NEW PATENTS—1886.

7080. "Arc electric lamps." W. R. JOHNSTON. Dated May 26.

7107. "Holders for incandescence lamps." R. A. SMITH. Dated May 27.

7109. "Electro-telephonic apparatus." A. A. C. SWINTON. Dated May 27.

7147. "Galvanic batteries." E. TUTEUR. Dated May 27.

7151. "Holder for the reflector and shades of incandescent lamps." A. L. FYFE. Dated May 27.

7177. "Electric measuring instruments (ampère and voltmeters)." R. ALIOTH & Co. Dated May 28.

7189. "Primary voltaic batteries." J. E. PEARCE. Dated May 28.

7251. "Making carbon filaments, &c., for incandescent electric lamps." W. MAXWELL. Dated May 31.

7270. "Combined dynamo-electric machines and motors." P. W. WILLANS. Dated May 31.

7277. "Dynamo-electric machines." A. LE N. FOSTER, F. V. ANDERSEN. Dated May 31.

7279. "Regulator for high tension electric currents." A. H. BYNG. Dated May 31.

7294. "Globes or receptacles for electric lamps." F. H. VARLEY. Dated May 31.

7311. "Multiple electric conductors or cables for telegraphic, telephonic and other purposes." B. J. B. MILLS. (Communicated by J. J. C. and M. Smith.) Dated June 1. (*Complete.*)

7329. "Automatic telegraphic apparatus or devices." J. H. JOHNSON. (Communicated by E. J. Mallett.) Dated June 1. (*Complete.*)

7342. "Amalgam for voltaic electric elements." R. H. COURTENAY. Dated June 1.

7353. "Galvanic batteries." P. R. DE FAUCHEUX D'HUMY. Dated June 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3941. "Dynamo-electric machines." J. SWINBURNE. Dated March 27. 8d. According to the invention, a dynamo has its poles arranged as in the well-known Hefner Alteneck or Ferranti alternating current machines, but the armature and commutator are so arranged as to give direct currents. The machine may have any convenient even number of pairs of poles. If it has two pairs of poles, it may have three or five coils. One set of ends of the coils are joined together and the other ends are led to three or five segments forming the commutator. Two brushes collect at opposite sides, and these brushes are broad enough to bridge well over the insulation between the segments. By this means generally two of the three coils are working in series and the third is idle, but while the brush touches two segments two coils are in parallel with each other, and together in series with the other. The brushes may be made broad enough, or the commutator segments may be cut obliquely to prolong this. Five coils work similarly.

7510. "Improvements in the continuous manufacture of light metals by application of electrolysis and in apparatus therefor." P. JENSEN. (Communicated from abroad by J. Omholt, of Norway, and the Chemische Fabrik Gössnitz, Böttiger and Seidler, of Germany.) Dated June 19. 8d. Consists of a suitable arrangement of a number of half retorts or bottomless retorts placed horizontally in a furnace or muffle, further by a suitable combination of these retorts with suitable receivers, as well as by leading away the light metals formed in the retorts in a melted or gaseous state in the receivers without interrupting the action of the electric current. The metals collected in the receivers are from time to time taken out in a heated condition and are allowed to cool, the air being excluded.

7733. "Improvements in electrical batteries." H. C. B. SHALDERS and A. J. THORMAN. Dated June 25. 4d. Consists of copper and zinc plates placed in damp sea-weed.

13,036. "Improvements in the manufacture of carbons for incandescent lamps." A. Bernstein. Dated October 29. 8d. Consists in making a carbon filament entirely out of hard and dense carbon, which is obtained by the decomposition of a liquid or gaseous carbon compound, and without any filament to deposit on. In order to accomplish this the inventor uses a vessel containing a carbon compound, which is decomposible by heat, and which compound may be in the form of a liquid or vapour. On the bottom of the vessel he places a conductor, say a piece of copper, which is connected with the negative pole of a suitable

current generator. Then he suspends a wire, which is connected with the positive pole of the generator, in such a way that it may be made to touch the copper, and can be gradually and slowly withdrawn from it by suitable mechanism. As soon as the wire is withdrawn from the copper an arc is formed between them, and as the greatest heat is at the end of the wire which forms the positive pole, a deposit of carbon takes place at the end of the wire. The deposit so formed shortens the arc, but if the wire is withdrawn at the same rate at which the deposit is formed the result will be that a filament is gradually formed at the end of the wire, which filament consists entirely of a hard and dense carbon. The filament may be of any length, and the thickness of it can be varied by the varying speed given to the motion of the wire.

1886.

932. "Improvements in dynamo-electric machines, and in the transmission of power thereto." A. LE NEVE FOSTER and F. V. ANDERSEN. Dated January 21. 11d. The objects of the invention for improvements in dynamo-electric machines, and in the transmission of power thereto, are as follows:—1. To provide more efficient means for securing or mounting an annular armature on its shaft. 2. To arrange, or construct, the bearings for the armature shaft in such a manner that the said bearings, together with the armature, commutator, and brushes, can be withdrawn from the bed plate without affecting the other parts of the machine. 3. To provide efficient means for varying the positions of the brushes employed to collect the current from the commutator of a dynamo-electric generator, so that the lead can readily be adjusted. 4. To provide means whereby the position of the whole machine may be adjusted without interfering with its foundation, so as to allow the belting by which the machine is driven to be readily tightened as may be required. 5. To provide means whereby the direction of rotation of the armature will be constant, even if the direction of rotation of the prime mover is reversed, and thus dispense with the ordinary mechanism and double set of brushes by which the lead is adjusted, and the current maintained in a constant direction on the reversal of the armature shaft.

2002. "An improved method of applying electricity to the scalp or head for curative and other purposes." G. LICHTENFELD. Dated February 11. 4d. Consists, essentially, in adapting to wigs, part wigs, head-dresses generally, caps, hats, bonnets, and other descriptions of head-gear, or coverings for the hair and head, of any suitable constant battery, by means of which a continual or constant current of electricity can be obtained and applied to the scalp or head, or any part thereof, as desired.

CORRESPONDENCE.

Central Station Lighting.

My attention has been called to a report which recently appeared in the *Times* of the inspection of a new installation of electric lighting at Paddington. The report states that this installation is "the first practical example of electric lighting from a central station by a direct current."

In common justice to a body of gentlemen who have subscribed capital and thrown their energies gratuitously into the establishment and working of a central lighting station at Eastbourne for the past four years, I am assured you will permit me to contradict this statement.

The Eastbourne Electric Light Company was incorporated in February, 1882, for the purpose of supplying electric light from a central station; and by September of that year the company had laid over 8,000 yards of cable and commenced lighting. The Grand Parade, several of the more important streets of Eastbourne, and a number of shops and hotels were supplied with arc lamps.

The question of incandescent lighting was carefully considered, and within a few months from starting the directors were enabled to supply this light, and it is now largely used both for business and domestic purposes. The company have also secured the lighting of St. Saviour's Church.

That the consumers are well satisfied with the company's exertions is best shown by the fact that the circuit has just been extended by 4,000 yards to meet the increased demand for the light.

Eastbourne may therefore fairly claim to be the pioneer of electric lighting in its commercial aspect, and this credit it ought to enjoy.

Henry Turner,
Secretary Eastbourne Electric Light Co., Ltd.

May 28th, 1886.

[We do not expect to see aught but blundering when the *Times* takes in hand anything electrical. The recent notice in that journal of the Langdon-Davies "phonophore" is an example of newspaper science.—EDS. ELEC. REV.]

Long Distance Telephony.

On reading the paper on "Long Distance Telephony," by Mr. W. H. Preece, I was rather astonished by one or two startling assertions he makes. Speaking of noises on wires from external sources, he says, "It was quite easy to eliminate the effect of external disturbances by the use of a twisted metallic loop." Doubtless it seems very easy in theory, but is not so in practice, especially on long lines, which I understand Mr. Preece refers to.

Apparently it was not so easy in the case he mentions just before, where on a line from Regent's Park to the General Post Office (distance four miles) telephonic communication could never be carried on. By the way, this does not say much for the Post Office lines. Is this one of the improvements in working effected by them? I have enquired, but cannot find anybody who has heard of the said improvements. Where are they? What are they? Perhaps in the systematical arrangement at Newcastle. There must be some error in the description of this arrangement, as no sense can be made of "Double wires were in use everywhere, and the telephone instruments were joined to the wires in parallel. By this arrangement, and having the call indicators of rather large dimensions the telephonic currents could not pass through the indicator owing to the magnetic inertia, but could only pass through the telephone whose indicator was cut out of circuit." Can a single instrument be joined up any other way except in parallel? What have "rather large indicators" got to do with "magnetic inertia"? and if a current owing to the "inertia" cannot pass through the indicator, of what use is the indicator? Perhaps this is the reason that the long-suffering subscribers in Newcastle ring for 20 minutes or half an hour without an answer, and they have to send a boy round to get put through. From North Shields to Sunderland is only about eight miles (direct), but notwithstanding the admirable arrangement of the Post Office system, it is impossible to carry on conversation between the towns. Want of space forbids my entering into further details, but I certainly disagree with Mr. Preece's statement that the Post Office engineers have effected the "only improvements in telephone working."

A. Watts.

May 26th, 1886.

I have read the reports of Mr. Preece's paper before the Society of Telegraph Engineers, with some surprise.

It certainly seems a little strange to me, considering the wonderful perfection of the Post Office as laid down by Mr. Preece, that they have not got more subscribers, and also that in those towns where they have opened exchanges—with the exception of Newcastle—they have I believe been beaten by the private companies. Mr. Preece holds up the system of Newcastle as an example of perfection in telephony, but if the Post Office are so proud of their arrangements, it seems strange that they will not allow anyone with a knowledge of telephony to see their apparatus, while Mr. Preece has, I believe, visited many of the principal exchanges of the private companies.

I should like to know what improvements have been made by the postal telegraph engineers in telephony, because, though I have had considerable experience of this work, I cannot at present think of any. I agree with the remarks of Mr. Preece that the telephone has been

stifled by a "grasping monopoly." Perhaps when Mr. Preece made this remark he was thinking of Newcastle, where a private company opened an exchange and obtained considerably over 100 subscribers. The Post Office authorities compelled the company to close their exchange and then canvassed the town, the company's exchange being closed for about 12 months.

This, I think, is a fair example of a "grasping monopoly." But this is not all; the Post Office finding that they could not stop the private companies, have seriously interfered with their establishing that trunk communication between towns of which Mr. Preece seems to think so highly.

This, no doubt, has resulted in delay, but the opposition of the private company to this "grasping monopoly" will probably yet be found inconvenient.

Slabee.

In looking over the report of the meeting of the Society of Telegraph-Engineers and Electricians in your issue of May 21st, 1886, I was very much struck by one or two remarks made by Mr. Preece, who says that no improvements have been made on the Bell telephone; if this is so, how does it happen that the Post Office prefer using the Gower-Bell, if the Bell is a superior instrument; and surely the Blake transmitter is allowed to be a vast improvement, for commercial purposes, on the Edison?

Again, Mr. Preece states that in no country has the telephone been so fully developed and systematically arranged as at Newcastle. This is saying a great deal, and I am of opinion that on inspection it would be found that the exchanges established by private companies, both in London and the provinces, are equally well, if not better, arranged than at Newcastle.

Then, as to improvements in telephone working having been made by the Post Office staff, I think the greater praise is due in this respect to the metropolitan and provincial companies, where, indeed, telephone working has greatly improved during the last year or so.

Telephonist.

May 25th, 1886.

[It would save a great deal of trouble if our correspondents would be more careful to read correctly the reports of meetings, or, if they attend the latter, to be careful not to misunderstand plain statements; there may no doubt be much to which exception may be taken in the conduct of the Postal system, but people should look before they leap and avoid incorrect and illogical statements. First with reference to the letter of our first correspondent. The elimination of external disturbances by the use of a twisted metallic loop is an accomplished fact and not merely a theoretical idea. The lines on this principle erected between London and Brighton, and between London and Liverpool, are both practically free from external disturbance, and on some sections where extra care has been taken in symmetrically arranging the wires there is absolute silence. As regards the wire between Regent's Park and the Post Office, this circuit, which is single and not double, has been placed at the disposal of inventors who have asserted, and have been desirous of proving, that their apparatus would eliminate inductive disturbances on a *single* wire telephonic circuit. With respect to the question of the improvements effected, the fact that a particular individual has never heard of a certain Mr. Smith is a not uncommon but hardly a conclusive argument in proof of the non-existence of that gentleman; besides, it is not usually the case that a trading company publishes to the world all the details of its working arrangements or states publicly the methods by which it is enabled to carry out its work efficiently. As to the criticism of the description of the Newcastle method of working, we may remark there is no error in the description of the arrangement; we are sorry that our correspondent is so far behind the time as not to know what "magnetic inertia" is or that the latter is in proportion to the mass of iron in a magnet; we are also surprised that he does not know that a telephone indicator is actuated by a battery and not by a telephonic current. It is quite possible that in one or two instances, owing to "faults" (and what system, however near perfection, is not liable to faults), a subscriber may have been temporarily inconvenienced, but that such failures continually occur, as our correspondent implies, is not correct. As to the impossibility of communicating between North Shields and Sunderland, not only is this statement absolutely untrue, but daily communication is also carried on through the 8 miles of wire in question with an additional length of 32 miles or 40 miles in all, *i.e.*, between Newcastle and Middlesborough. We believe that if application is made in the proper way every facility would be given to an applicant to see the postal telephonic apparatus. One reason why the Post Office have not got more subscribers is, that their rental charges are higher than those of the companies, a consequence of the greater perfection of their system involving heavier maintenance expenses. Coming now to the action of the postal authorities in regard to the company's exchange at Newcastle, we believe that this exchange was in the first instance started without the license of and in defiance of the Postmaster-General, a fact which our correspondent avoids mentioning; there are also other facts in connection with the case which if known would put a very different complexion on the matter. Lastly, we come to our correspondent "Telephonist." Mr. Prèece did not state that the Bell was a superior instrument to any other, what he did say was that no instrument was superior to the Bell, *i.e.*, that there might be some as good but none better; moreover, Mr. Preece distinctly stated that the Post Office were only enabled to carry out their telephonic system owing to the fact that they had secured the right to use 20,000 Gower-Bell instruments; we believe that at the present time they could not employ any other form except by the permission of the holders of the Bell telephone patents. The mere expression of "opinion" that the Newcastle exchange would prove "on inspection" to be inferior to others, it is needless to say, goes for nothing, in the absence of proof. We, "who know," hold a different opinion. Coming now to the last paragraph of "Telephonist's" letter, we would refer him to a recent number of *Punch*, in which a description is given of the working of a telephone exchange system in a certain large town.—EDS. ELEC. REV.]

The Bell Telephone in America.

I hasten to send to the REVIEW a synopsis of the answer filed by the Bell Telephone Company to the suit brought by the United States. This synopsis was published this morning in a newspaper which obtains information from *head-quarters*, and is generally to be relied on. I have not had time to examine carefully for legal decisions which may have a bearing on this case; but I am clearly of opinion that the Court in Ohio will not sustain the demurrer, but will decide that when a corporation is doing business on a patent right, which the U.S. Government alone can grant, a suit can be brought by the U.S. Government in any district where such corporation is doing business.

The more I have examined the Bill and exhibits filed by the Government against the Bell Company, the more I am convinced that the prosecution will fail to establish fraud in obtaining the patent; and I still hold the opinion I expressed in my letter published in the REVIEW of March 12th, that the Government, in the absence of any statute, can bring a suit to annul a patent for *fraud only*.

The fraud alleged in the Bill is that the caveat of Gray was filed in the Patent Office *before* Bell's application for a patent was filed, and that Bell or his agents fraudulently obtained from the files information as to what were the principal features in Gray's caveat.

From the records of the Patent Office it is esta-

blished: 1st. That both applications were filed on the same day—14th February, 1876. 2nd. That Bell's application was filed before Gray's caveat. The part of Gray's caveat put into Bell's specification as amendments on 29th February, 1876, is concerning the "*undulatory*" current; that sort of current is named in Bell's original specifications, and the claims granted in his patent are word for word the same as those originally filed on 15th February, 1876.

Should this suit ever be tried I am of opinion that the only question which the Court will hear is that of "*fraud*," and the result will be that no fraud can be proved.

I have, after several years' research, found the original publication containing a full account of Bourseul's telephone, written by himself, and published in 1854, and I shall send you shortly a correct translation of it.

W. C. Barney.

McPherson House, Washington,
May 18*th*, 1886.

The Incandescent Lamp Patent Case.—Second Action.

In the absence of all verbal evidence on behalf of the defendants in the above case, Mr. Justice Butt could scarcely avoid following the weight of scientific evidence given by the witnesses for the plaintiff company, although it appears he noticed some discrepancies in one part or the other of their examination.

Presuming the admitted publication of Despretz's discovery would waive all legal difficulties as to the utilisation thereof by the public at large, the practical points alone remain and on these the learned judge based his judgment; these appear to be three in number, viz.:—

1. Sir Frederick Bramwell, he says, showed in substance that uniformity of heat produces uniformity of deposit per unit of area, and that is just what you do not want in forming a carbon conductor as described by Cheesbrough.

2. That Prof. Dewar intended to abide by this, that one could not cure the porosity of carbons without the gradual increase of current.

3. That Dr. Hopkinson says, Despretz's publication on "Volatilisation of Carbon" would be more likely to deter, than tc invite an inventor of incandescent lamps to look into it.

On each of the above statements an experienced operator in the process of flashing—the technical name now used for the electro- or thermo-deposition of carbon on other carbon—in his evidence would, I think, have made such comments as materially to have influenced the final opinion of the judge and possibly altered his verdict.

In answer to No. 1, while agreeing that "uniformity of heat produces uniformity of deposit per unit of area" is a recognised scientific law, he would qualify the assent with respect to the case in point, for here to obtain a uniformity of heat to uniformity of area, it would be practically impossible unless the *sectional area* of the filament was similar throughout its length; and then an even temperature would be exactly the desideratum by producing an equal deposit. When a filament is of a varying section, the intensity of heat will vary as the section and so will the deposition, thus *automatically* bringing the carbon to a proper thickness and regular density.

In reply to No. 2, "That without a gradual increase of current the porosity of a carbon could not be cured," he would say, The best results in closing the pores and building up a carbon are attained by the use of the highest temperature consistent with the physical cohesion of the filament; and the ampère current to produce this will vary with the section and the density of its substance. As an instance that the highest temperature is essential, it sometimes happens that the electromotive force available is not sufficient to raise the temperature rapidly; the deposit suffers in quality, frequently producing a roughness on the surface of the filament, like unto small trees. This fact shows that a proportionally high current is required at all stages of the flashing process. If, however, instead of ampère current the power employed or energy is taken in watts, then, in place of increase of current the converse ensues, the watts safely absorbed being a constantly diminishing quantity, the E.M.F. falling and ampères rising, the latter varying with the section and density of the filament, and apparatus has to be fitted up to specially allow for this. But in the Despretz experiments where a carbon of considerable bulk was used, which would stand all the available current, the deposition would lower the resistance, thus raising the ampère current *automatically*, and unavoidably unless special precautions were taken to lower the E.M.F. in a like manner when flashing thin pencils or filaments.

In regard to No. 3, Dr. Hopkinson's statement is simply a matter of opinion, and in opposition to him a practical inventor with any experience of incandescent lamp manufacture, would, for more reasons than one, seize with avidity a paper with the title "Volatilisation of Carbon," which might present to him the cause of blackening bulbs and perhaps lead to the means of avoiding this fault.

Practical evidence would thus have tended to show that the effects resulting from certain processes, published over 30 years ago, automatic in their action and part and parcel of the operations as a natural physical result, would, though undescribed, appertain to the manufacture and therefore could not be entitled to be considered a proper subject for separate letters patent for a process precisely similar to Despretz's. If it were not generally known to the contrary, the absence of witnesses on behalf of the defendants might give rise to the idea that the action was arranged in some manner to the mutual advantage of both parties.

Ram.

Schanschieft's Battery.

Will you kindly allow me to reply to the letter of Mr. Edward Conry in your last issue. Mr. Conry says he has tried my battery. I have written him asking him from whom he obtained my solution, to which he has not replied. I think I am justified in concluding from the text of his letter that he has never tested *my* battery, but has simply tried some of my solution with elements from a bichromate cell. He says the E.M.F. is not greater than in the old bicromate. I have never claimed that it is. He says the battery has an unpleasant habit. My battery has no habits, pleasant or unpleasant, nor has it any crystalline deposit on the zincs. The deposit on Mr. Conry's zincs "reminds him of green chromate;" doubtless it does. It is evidently crystals of chrome alum displaced from his porous carbons by my exciting solution.

It is a question which is continually being put to me whether my solution can be used with elements from a bichromate battery, and I have as often to caution enquirers that the work of the solution would be utterly spoilt.

There is no necessity to squeeze the deposit in the cells through washleather. I purchase the deposit as it is at 1s. 4d. per oz., equal to 2s. 2d. to 2s. 6d. per gallon, according to the degree to which the liquid is worked out.

Mr. Conry thinks my battery is not as good as one or two single liquid batteries we have already.

Fortunately his opinion does not influence facts.

I challenge Mr. Conry to produce any other single liquid battery of equal size which will give *only* six hours continuous work.

I can positively assert that Mr. Conry never applied to me for nor received direct from me (sole manufacturer of Schanschieff's Batteries and Solution) either battery or solution. If he will apply he will certainly receive every facility to make a proper test.

A. Schanschieff.

June 1*st*, 1886.